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The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Cast Iron under Combined Stress.—I

Cast iron had a considerable share of the limelight in the Paper recently given to the Institution of Mechanical Engineers by Dr. Gough and Mr. Pollard, of the National Physical Laboratory. At the discussion speaker after speaker expressed interest in the behaviour of the cast iron. The authors have recently developed an ingenious machine capable of submitting a test specimen to two types of cyclical stress simultaneously, bending and torsional, thus using types of combined stress that occur, for example, in an engine crankshaft. A programme of research was then undertaken on fourteen steels and three cast irons, these three being a comparatively brittle, a normal and a comparatively ductile type, all supplied by the British Cast Iron Research Association. The Paper referred to covered two steels, one a mild steel, one a heat-treated alloy steel and one of the cast irons, this being the type containing about 5 per cent. silicon and hence rather hard and brittle.

Now theories as to the way materials really fail are varied, and they have hitherto remained theories because there has been no way of applying controllable combined stresses to them. This the above-mentioned machine, described in the Paper, supplies. While it does not exhaust the varieties of complexity of stresses the designer is faced with in practice, it does cover a substantial portion of the field once and for all.

The cast iron proved to be very uniform and to have fatigue characteristics of exceptional interest. Not much work has been done on the fatigue characteristics of cast iron, but what has been done shows it to have a rather high endurance ratio. The ordinary static tensile strength of a material is well known to be much higher than the strength at which the same material will fail under fatigue conditions, *i.e.*, if the stress is repeated an indefinite number of times. The ratio of the latter to the former is usually called the endurance ratio, and for the steels is usually about 0.4. Tests carried out on the Continent and in the United States show that ordinary good irons may be expected to come a little more, and alloyed irons still higher. The N.P.L. tests on fatigue on the brittle iron showed it to have an endurance ratio of unity, that is, the metal was as strong in fatigue as in direct tension, the first time such a result has been recorded. The results of the combined-stress tests will be dealt with in a later issue.

Road and Rail

In his broadcast speech last Saturday, Mr. Neville Chamberlain announced that the Government intended assisting the railways by guaranteeing loans for the financing of improvements in all parts of the country. In addition, he announced a five-year plan for the improvements of roads, involving an expenditure of £100,000,000. Naturally, this will have a great influence on the foundry industry. We admit to a profound ignorance on the question of road construction, but we have noticed in Middlesex that, when the County Council becomes really in earnest about the repair of an important arterial road, they have at their disposal apparatus comparable with a highly mechanised foundry. There are combined road rollers and diggers, conveyors, and concrete mixers. Whether the main roads are to be drained or not we are unaware, but, if a river be near by, the tar-contaminated water is detrimental to the well-being of the fishing rights, and this for considerable stretches should involve the use of gulley grates. But so far as the foundry industry is concerned it is the reaction on automobile building which is of the greatest importance, and an assurance of continued, if not increased, prosperity can be looked for. According to "The Times," the railways soon hope to reconstruct, with Government help, Euston and Lime Street, Liverpool, stations. The former proposition alone would cost between £5,000,000 and £8,000,000. The Great Western has the intention of relaying some 400 miles of track and improving about 50 bridges, whilst the London Midland & Scottish has announced for their 1936 programme, an expenditure of £2,232,000 on nearly 10,000 passenger and goods vehicles. These schemes involve much work for foundries other than those normally engaged in manufacturing railway castings, chairs, axleboxes and the like; for instance, the reconstruction of Euston station alone would probably involve, at a minimum, the use of 1,000 tons of rainwater goods alone. Even the manufacture of bricks, tiles and glass involves a consumption of castings. On the construction of new passenger vehicles there is involved the supply of lighting sets, innumerable small brass castings for handles, brackets, and even ash trays. It does seem that the foundry industry can look forward to a period of increasing prosperity, especially as shipbuilding and other industries are also experiencing improved conditions.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Papers for the Glasgow Conference

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—For many years the Papers given to the Annual Conferences of the Institute of British Foundrymen have been arranged by invitations to prominent foundrymen and metallurgists to prepare and present Papers on subjects upon which they are authorities.

The Council of the Institute has decided, in future, to issue an open invitation to authors to submit Papers for consideration. A limited number of such Papers will be selected for inclusion in the programme in addition to Papers which are arranged by invitation as heretofore.

The next Annual Conference of the Institute will be held in Glasgow from June 9 to 12, 1936. Authors who desire to submit Papers for presentation at this Conference are requested to forward either the Paper or a synopsis to the undersigned not later than December 31, 1935, so that the Council of the Institute may make a selection.—Yours, etc.,

TOM MAKEMSON,
Secretary.

Institute of British Foundrymen,
St. John Street Chambers,
Deansgate, Manchester, 3.

November 5, 1935.

Cupola Melting Rate

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to the above heading—Cupola Melting Rate—I am of opinion that a definition giving minimum melting rate could be quoted, based on specified conditions of tuyere ratio and coke ratio. From my experience, with total tuyere area of one-fifth the cross-sectional area of the cupola at tuyere level, one pound of coke per hour per square inch of the cross-sectional area at tuyere level will be burnt. From this fact the minimum melting rate of the cupola can be calculated from the coke-iron ratio. Any increase on this figure due to wider melting zone as the lining is burnt back will give mutual satisfaction to both buyer and seller.

With regard to this loss in lining, Mr. S. E. Dawson, in his letter in your issue of October 24, was quite safe when generalising, but the production of the table showing increase in cross-sectional area of cupolas based on the assumption of a loss of 1 in. of lining per hr. tempts me to join issue with him.

First, is this assumed loss of lining based on any actual measurements? If not, then the table loses all its significance. If the answer is in the affirmative, then it is not in agreement with my findings. I have conducted a large number of cupola tests, and I have proved to my satisfaction that a fairly large amount of loss in lining occurs during the blow down, and that this "blow-down loss" does not vary a great deal whether the cupola is in blast for 4 hrs. or 20 hrs. Therefore the loss is not in direct proportion to the duration of the blow, but the amount of fettling required after, say a 4-hr. blow, would be nearly two-thirds of that required after an 8-hr. blow, and perhaps one-half of that required after a 20-hr. blow. Mr. S. E. Dawson's figures for these conditions would be one-half and two-fifths respectively.

Secondly, considering that the average burning back in the melting zone takes convex formation, where does Mr. Dawson take his measurement?

Thirdly, does Mr. Dawson wish us to conclude that the burning back of the lining at the

(Concluded on page 358.)

District Presidents.—No I

SCOTTISH BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN

MR. DANIEL SHARPE, the newly-elected President of the Scottish Branch of the Institute of British Foundrymen, has had a wide and varied experience in foundry and metallurgical work. He received his early education in various Glasgow schools, and later at what is now known as the Royal Technical College, Glasgow. He gained his practical metallurgical training, as so many leading men of the iron and steel industries did, in the Steel Company of Scotland, Limited, where he spent six years, four in the laboratory of Blochairn Works, Glasgow, and two years as melter and sample passer on the open-hearth furnace bench. Mr. Sharpe then became chemist and assistant foundry manager with the Acme Steel & Foundry Company, Limited, Shettleston, with whom he remained about two years when he returned to the Steel Company of Scotland to become steel foundry

MR. DANIEL SHARPE.

manager at the Hallside Works, Newton. Later Mr. Sharpe was appointed manager of the National Steel Foundry Company, Limited, at Leven, Fife, afterwards becoming a director of the company.

In 1920 Mr. Sharpe, having undertook a commission as consulting engineer, went to the United States of America, where he spent more than a year visiting over 100 iron and steel foundries. During this visit to America Mr. Sharpe became particularly interested in the Sandslinger system of moulding, and returned to Britain to develop the European patents of this machine, a direction in which his activities were concentrated for some years.

At present Mr. Sharpe is joint managing director of Messrs. Walter Macfarlane & Company, Limited, Saracen Foundry, Possilpark, Glasgow. He is also a director of Messrs. A. & W. Smith & Company, Limited, engineers and manufacturers of sugar-mill machinery; Messrs. R. G. Ross & Company, Limited, steam- and air-hammer makers; Messrs. Foundry Plant & Machinery, Limited, the manufacturers of the Sandslinger machine; and Messrs. B.I.A. Patents, Limited, etc. Mr. Sharpe has delivered Papers before practically every Branch of the Institute of British Foundrymen. He is also a member of the West of Scotland Iron and Steel Institute and of The Institute of Vitreous Enamellers.

Tin Position Still Dangerous

BY "ONLOOKER."

The alarming statistical position of tin, with stocks in the United Kingdom at vanishing point, has compelled belated action by the International Committee in the shape of decisions to increase the production quota first to 70 per cent. retrospective to July 1, and almost immediately afterwards by a further 10 per cent. to 80 per cent. Not unnaturally, the first result of this was to bring the quotation down with a run, and to reduce the premium for spot metal, which nevertheless stands at about £10. Although some time must elapse before the additional tin made available is going to show up, the October statistics record an increase in visible supplies of about 1,500 tons, bringing the total up to 12,500 tons, or less than half what it was a couple of years ago.

This tardy capitulation by the Committee is certainly going to make matters easier in due course, but in the meanwhile this country, at a time when a state of international tension exists, is faced with the disagreeable fact that stocks are down to the beggarly total of a few hundred tons. Why the Board of Trade, which recently instituted a thorough-going inquiry into the lead and spelter positions, should have allowed such a state of affairs to develop without interfering is something of a puzzle, but perhaps the authorities thought that it was only right that those who had made the mess should clear it up! The idea may be sound, but a study of the manner in which the affairs of tin have been conducted during the past twelve months does not promote much confidence in the ability of those who control the situation. Rarely, if ever, in the history of this metal have we seen such amazing price fluctuations, and yet the International Tin Committee set out to promote stability in the quotation!

Recent shipments of tin from Holland to this country have helped to ease the situation a little, but for some time there will be a shortage of prompt metal, coupled with all the inconvenience that such a situation brings in its train. As supplies increase, and the alteration in the quota should release for consumption this year several thousands of tons of additional metal, the price is bound to suffer, and there cannot be much doubt that by the second half of this month or early in December a change will be seen in this respect. It is probable, therefore, that buyers will exercise great caution and are not likely to commit themselves very far ahead.

An increase in supplies of prompt tin would certainly be a relief to the metal exchange, where the shortage has brought about a big backwardation calculated to make hedging business almost impossible. One way and another, the policy pursued by those in control of the tin situation has brought things almost to a standstill, and everyone would be very glad to see a return to normal conditions of trading. There are those who consider that increasing to 80 per cent. of standard will put production in excess of consumption, and this may well prove to be the case, but the circumstances were such that anything less would have been inadequate to meet the situation.

So, with the prospect of adequate supplies of tin becoming available, we can look forward to the end of an inglorious chapter in the history of the metal and a return to sanity. Just where the price will settle down it is hard to say, but those who have sacrificed everything in order to raise prices will have to be satisfied in the future with a level more in keeping with the general range of non-ferrous metal quotations. Already scarcity of supplies, and an inflated price, have encouraged the search for substitutes, and development in the newer areas of production.

Metallurgical Progress in the Foundry*

By S. E. DAWSON, F.I.C. (Stanton Ironworks Company, Limited)

On accepting the invitation of our Branch Secretary to give a lecture this evening, I had to consider somewhat hurriedly as to a suitable subject which would be, I thought, not only of interest to ourselves, but would stimulate thoughts in one or two directions in the foundry industry generally. I had in mind perhaps, the Presidential Address of Mr. J. F. Driver delivered to the East Midlands Branch of the Institute on the occasion of their first meeting of the session a few weeks ago, when he compared very ably in the short time at his disposal, the past and the present conditions prevailing in the foundry. He even gave us a glimpse of the possible foundry of the future, his speculations thereon being both interesting and entertaining. Such a review is always of value in that it puts our mind into a train of thought to get into better perspective the developments which have taken place and are taking place in foundry practice. On such occasions, one still hears murmured regrets at the alleged passing of the responsibility for quality from the skilled craftsmen to the technician now established in the modern foundry.

It is not the intention to replace the craftsman's skill, but to supplement it in a direction which is beyond the scope of such craftsmen, and is the natural sequence to the developments taking place in the evolution of cast iron as one of the principal engineering materials of to-day and the future, and which may be summed up in the word Progress. No metallurgist or foundry engineer would claim to replace the skilled craftsman in the making of the mould, but it does not follow that a casting produced in a perfect mould will necessarily meet the requirements of the industry for which it is intended. In addition to a sound, clean, casting, the engineer to-day expects that the iron itself has such qualities that he has allowed for in design and application. That he can now legislate for many special properties in cast iron as well as rely on higher minimum strengths than formerly, indicates the progress in our knowledge of the metallurgy of cast iron, since the days when a casting was largely judged by its appearance, soundness and machinability, and little attention paid to the economic possibilities of reduction in thickness and weight.

The Newer Conditions

Adequate recognition has not yet been made of the improvements obtained, largely owing to economic reasons, although the lighter sections employed to-day are proof of appreciation if sometimes operating to the financial disadvantage of the foundry. The introduction of technical skill has not been limited to the metallurgists, however, and many foundries to-day testify almost as much to the engineer's art as to that of the moulder. Transportation conveyors, moulding machines, sand blast plant and the many other devices to assist the moulder in his craft are evidence of the necessary co-operation between the foundry engineer and the craftsman.

Knowledge and understanding of cast iron have advanced more rapidly than that of any other engineering material, and, in spite of its complex nature, the many structures with which one is familiar in steel can now be more or less isolated in cast iron. Apart from special properties produced by alloy additions, the most influential constituent of cast iron is carbon, and perhaps mainly in its form as graphite, especially as regards its condition. In most cases, the smaller the graphite in the iron the better will be the casting in its physical properties, and with experience the skill of the moulder in gating, running and feeding to suit may be relied on to give a sound casting.

Generally speaking, the conditions which produce small-sized graphite also give a small grain size in the structure of the metal with well-known advantages to the strength of the casting. A close and fine graphite structure also tends to equalise the grain size in different adjacent metal thicknesses or sections, such as are met with in automobile cylinder blocks and similar castings. Such a structure is promoted by higher melting temperatures and by suitable adjustments in composition dependent on the rate of cooling prevailing in the casting.

Lower total carbon itself tends to produce smaller-sized and better-distributed graphite, as well as a lesser grain size, the latter often of finer pearlitic formation. The theory underlying this fine-graphite formation was at one time ascribed to the more complete solution of the original flake graphite in the materials employed, with the consequent removal or reduction in size of graphite "nuclei" which would induce and form the starting point of larger graphite flakes. This theory was perhaps conceived by the knowledge that the structure and properties of an iron could be altered by superheating, when the fracture of a casting was made closer.

Much consideration is, however, now being given to the structure and physical properties of the irons entering into the composition of the cupola charge, and much evidence is now available to indicate that the inherent properties of the raw materials employed persist through the subsequent remelting in the cupola to influence the resulting metal. This is of special interest both to the maker and user of special refined irons, and indicates the advantages of their use for special and high-grade purposes.

In a recent issue of THE FOUNDRY TRADE JOURNAL, Hurst showed that by the selection of raw materials of selected physical properties in addition to chemical composition, predetermined mechanical properties in the final metal can be secured by suitable blending. In perhaps a lesser degree, some scientific evidence is also seen for the use of scrap in most cupola charges which, whilst introducing a serious unknown factor into the calculation, is of somewhat different structure and of finer graphite form than pig-iron of similar composition. A study of the many influences which have been shown as effecting the structure and behaviour of cast iron afford some indication of the new light which is being brought to bear on the subject, and it is reasonable to suppose, or even predict, that the control of cast iron will include many factors in addition to that of composition.

Inherent Properties

In this connection, it is interesting to refer to the investigations carried out by A. L. Boegehold,* which were largely concerned with the examination of cast iron melted under constant conditions in a cupola from pig-irons produced in seven different blast furnaces. The cupola charges for the remelts included in all cases the selected pig-iron and scrap from a previous melt of the same pig-iron, and test-specimens were taken from the middle of the melt at a pouring temperature of 1,330 to 1,370 deg. C. He found that blast-furnace conditions produced characteristics in the pig-iron which persisted through subsequent melting in the cupola, as evidenced by many of the test results from both metals. This was especially observed with regard to hardness and fluidity in relation to composition, and the dilatometer test-curves which were of the same form in each pair.

The tests also showed in a marked degree the influence of the quality of coke employed and the amount of moisture in air supplied in both the blast furnace and the cupola. In particular, the combustibility or maximum burning rate of the coke largely controls operating factors such as rate of air supply and rate of melting. The effect of moisture in the blast increased the chill and combined carbon progressively when no similar influence due to composition could be

TABLE I.—*Effect of Remelting on Properties of Pig-Irons.*

Iron no.	Si.	Mn.	S.	P.	C.	Brinell.	Transverse. lbs.	Deflection. ins.	Kind of iron.
60.. ..	1.98	0.70	0.009	0.133	4.19	156	2,700	0.16	Charcoal.
X60 ..	1.90	0.70	—	—	3.90	195	3,700	0.19	
XX60 ..	1.83	0.67	—	—	3.79	170	3,500	0.18	
64.. ..	2.02	0.70	0.012	0.137	4.17	153	2,600	0.16	Charcoal.
X64 ..	1.91	0.61	0.013	0.136	4.04	179	3,450	0.13	
XX64 ..	1.87	0.57	0.015	0.139	3.96	167	3,300	0.13	
37.. ..	2.01	0.81	0.028	0.163	4.20	131	2,400	0.15	Coke.
X37 ..	1.99	0.78	0.033	0.176	3.83	152	2,450	0.17	
XX37 ..	2.03	0.71	0.038	0.173	3.80	131	2,300	0.115	
18.. ..	1.95	0.94	0.029	0.520	3.85	159	2,500	0.125	Coke.
X18 ..	2.09	0.95	—	—	3.74	165	2,850	0.15	
XX18 ..	2.06	0.95	—	—	3.74	170	2,800	0.12	
75.. ..	2.20	0.49	0.009	0.166	4.04	171	2,500	0.14	Charcoal.
X75 ..	2.15	0.48	—	—	3.86	170	3,200	0.13	
XX75 ..	2.11	0.45	—	—	3.82	153	3,000	0.12	
74.. ..	2.69	0.49	0.009	0.137	3.83	137	Holes	—	Charcoal.
X74 ..	2.47	0.49	—	—	3.79	167	3,500	0.16	
XX74 ..	—	—	—	—	3.67	166	3,550	0.13	
47.. ..	2.72	0.54	0.008	0.176	3.64	160	2,300	0.105	Charcoal.
X47 ..	2.64	—	—	—	3.60	159	2,500	0.13	
XX47 ..	2.56	0.48	—	—	3.53	149	2,800	0.135	
76.. ..	3.02	0.65	0.009	0.145	3.78	158	2,600	0.13	Charcoal.
X76 ..	2.84	—	0.009	0.139	3.78	163	3,650	0.135	
XX76 ..	2.86	0.65	0.009	0.131	3.72	170	4,000	0.135	
2	3.63	—	0.023	0.45	3.55	127	2,200	0.12	Coke.
X2 ..	3.67	0.93	0.024	0.458	3.33	128	2,200	0.10	
XX2 ..	3.70	—	0.028	0.463	3.20	116	2,100	0.125	

* Extracted from a Paper read before a Joint Meeting of the London and East Midlands Branches of the Institute of British Foundrymen, Mr. V. Delport presiding.

* Metallurgist, General Motors Laboratory.

XUM

observed, although the scattered results seen in Figs. 1 and 2 indicate that some other factors were also at work.

The effect of the quality of the coke may also be seen from the results obtained by W. E. Jominy in his comparative tests on irons melted by means of charcoal and coke. In all, about one hundred lots of iron were examined, and

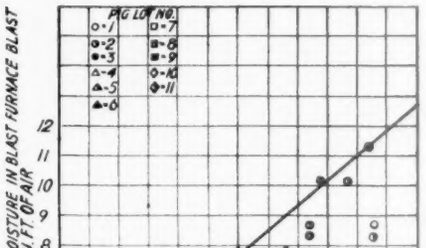
PIG LOT NO.
MOISTURE IN CUPOLA BLAST PLUS ½ MOISTURE IN BLAST FURNACE BLAST GRAINS OF WATER PER CU FT OF AIR
TOTAL DEPTH OF CHILL - INS.

Fig. 1.—Relation between Depth of Chill and Humidity of Blast.

again the pig-iron was remelted under constant conditions to reduce subsequent variables to a minimum. An electric furnace was employed for this purpose and the analyses showed that little change in composition had occurred. The iron was remelted at 1,430 deg. C., and, as in the case of the iron from the blast furnace, poured into test-bars 1¼ in. dia. by 15 in. long. The irons he employed were of considerable and useful range, and the mechanical tests taken included those on the original pig-iron as well as on the remelted and twice remelted cast iron. The tensile and transverse strengths in the case of the first remelt and for equal silicons are given in Figs. 3 and 4, which show the charcoal melted irons to be about 20 per cent. stronger than the coke melted irons.

On remelting a second time, this difference

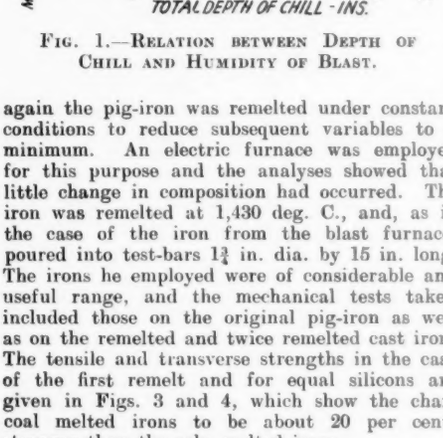
PIG LOT NO.
MOISTURE IN CUPOLA BLAST PLUS ½ MOISTURE IN BLAST FURNACE BLAST GRAINS OF WATER PER CU FT OF AIR
COMBINED CARBON

Fig. 2.—Combined Carbon as effected by Moisture in Blast.

had persisted, the actual comparisons in the three stages being shown in Table I. Whilst the analyses were similar in the comparative cases, the micrographs revealed a considerable difference in the structure, especially as regards graphite. In the charcoal melted irons, the graphite was small and well distributed, but in the coke melted irons it was coarse.

Influence of Silicates

In a different category perhaps is the influence on the iron of silicates of iron present in a colloidal or ultra-microscopic condition, sometimes referred to as silicate slime, shown by O. von Keil and others to produce large coarse graphite. The assistance rendered by the removal of such silicates by superheating the metal may be a direct contribution to the improvement in structure obtained by such treatment.

More recently the effect of treating cast iron with carbon dioxide in the presence of a small amount of titanium* with progressive refinement of the grain and graphite as such treatment proceeds, indicates a further direction in which a measure of control of structure may be obtained. Such evidence which is now being brought together on the many complex problems involved on the production of cast iron, may also influence the future design and manipulation of the cupola itself, and suggest at least that much greater care and control in melting should be exercised than is the case in many foundries.

Influence of Cupola Practice

It would seem quite likely that many valuable properties in the raw materials may be lost or diminished in remelting through the cupola itself, where the conditions of air supply, temperature and composition of the gases are not suitable. As illustration, one example, carried out by the author some years ago, may be cited for improvements obtained in the castings by a more suitable balance of air supplied to coke employed.

Table II (Fig. 5) shows the main items in the data taken:—

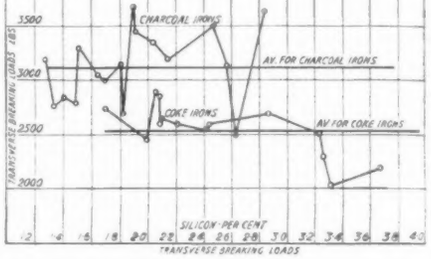

Fig. 3.—Transverse Strengths of Charcoal and Coke Irons.

Table II.—*Cupola Test Data.*

Test no.:	1	2	3	4	5	6
Air (cub. ft.) per lb. coke ..	233	197	183	179	164	165
Rejections	11 per cent.	8.7 per cent.	8.0 per cent.	6.8 per cent.	1.3 per cent.	1.0 per cent.
Ratio iron/coke	13.3	12.5	11.5	10.6	10.6	10.5
Time blowing (hrs.) ..	7.3	7.4	7.4	7.4	7.5	7.0
Rate of melting (tons per hr.)	7.67	8.5	8.35	8.0	8.0	7.6
Air per ton of metal (cub. ft.)	39,000	35,000	36,000	38,500	34,500	35 200
Dia. Cupola/Tuyere area ..	2.9	3.24	3.24	3.24	3.24	3.24
Temperature at spout (deg. C.)	1,330 deg.	1,340 deg.	1,370 deg.	1,380 deg.	1,390 deg.	1,400 deg.
Analysis—						
Total carbon	3.27	3.44	3.79	3.23	3.09	3.45
Silicon	2.69	2.30	2.15	2.29	2.38	2.42
Phosphorus	1.00	0.97	0.90	1.01	0.93	1.05

Observations were taken during each day's trial by the examination of several thousands of castings made from the same pattern and duplicates thereof. With the higher ratios of air, the iron was doubtless oxidised, and not until the proportion was brought to about 165 cub. ft. per lb. of coke could satisfactory castings be produced. This figure is about 15 per cent. higher than the theoretical volume of air required to burn a pound of average coke, and is a reasonable excess to expect under the circumstances of cupola melting.

In many foundries, the air-coke ratio is too low, with the result that carbon pick-up is experienced to the detriment of the structure and mechanical strengths, and the temperature of the metal is far from satisfactory. With a more correct ratio, the amount of total carbon can be better controlled to suit the particular castings to be poured, and with the absence of excess carbon, a close-grained iron obtained. In addition to those improvements which may be brought about by carbon control, the production of those cast irons with specific properties due to additions of other metals may be cited as distinct advances in the iron-foundry industry.

Amongst those in common use might be mentioned the irons to resist heat, corrosion and wear, non-magnetic iron, high electric-resistivity iron, irons for special duty rolls and irons for special heat-treatment, etc.

* British Cast Iron Research Association.

DISCUSSION

Mr. P. A. Russell, said Mr. Dawson had opened by discussing the nuclei theory, which was at a discount, and he agreed, but to the foundryman it is a very useful theory, and to explain the facts the theory gives reasonable explanation. In the results shown on the effect of moisture, comparing charcoal with coke, he was not sure that it was quite fair to put forward those results as attributable to the coke, as he understood that they were remelted in the electric furnace, and he did not consider they gave indicative results of metals melted in the blast furnace and remelted in the cupola. Mr. Dawson had also referred to the work of Dr. Norbury when bubbling CO_2 through the metal, and he could vouch for that, provided one had the correct amount of titanium. He thought we were possibly over-estimating the practical value. The figures of 28/30 tons tensile were rather misleading, as they were not from an "as-cast" condition. In ordinary straight irons it was not possible to produce more than 18 to 20 tons per sq. in. Regarding the figures of reduction in wasters with reduction of air, that was assuming that one was using too much blast. He thought that generally foundries used insufficient air, and he wondered whether similar facts could be given in the reverse manner, reduction of waste with increasing air. Also he would like to know what type of trouble was encountered in the castings when using the excessive amount of air.

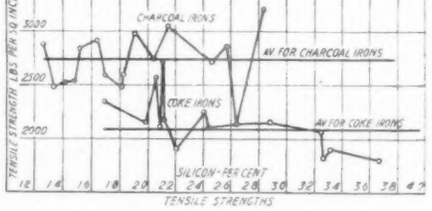

Fig. 4.—Tensile Strengths of Charcoal and Coke Irons.

(*Concluded on page 344.*)

Downward Trend of Foundry Profits

MR. SHARPE'S PRESIDENTIAL ADDRESS

The opening meeting of the 26th session of the Scottish Branch of the Institute of British Foundrymen was held in the Royal Technical College, Glasgow, recently. Mr. H. Hurst, retiring President, occupied the chair.

The CHAIRMAN welcomed the members and their visitors, and expressed the pleasure it afforded him to see so large and enthusiastic an audience. He had great pleasure in introducing Mr. Sharpe as the Branch-President for the ensuing session.

MR. D. SHARPE, on taking the chair, said that his first duty was to thank Mr. Hurst for his kind remarks and the members of the Branch for having elected him to the highest office in the Branch. He intended to leave no stone unturned to continue the work of his predecessors in the presidency. He thought that they should not let the opportunity pass of offering to Mr. Hurst their grateful thanks for the excellent work he had performed on behalf of the Branch during the past session, and he asked them to accord in the usual manner an expression of their thanks to Mr. Hurst.

The PRESIDENT then read his address, in the course of which he said:—

MR. HURST AND GENTLEMEN,—After a fairly long and varied experience in the foundry trade, I feel induced to make some comparisons between the past and present conditions, and I will endeavour to show that a great deal of quiet development has resulted in economies, apart altogether from the admitted improvements in equipment.

Many foundries in this country are employing men whose fathers and grandfathers did similar work in the days gone by; they used the same floor space and had much the same conditions to work under as the present generation. It would appear to be accepted that the older generation of workers gave more time and thought to their work because of the more direct interest they had as craftsmen, and that the introduction of methods and machines which had taken away some of the more laborious work, had also taken away the initiative of the worker. I am not prepared to accept this for fact. There are in the foundry trade to-day many men who are showing great interest in developing improved conditions of labour, and are giving the workers much greater leisure as a result. It is a far view which will remove all the unpleasant duties from moulders and other foundry workers, but already many improvements have been introduced which must necessarily change the interest of the worker from some aspects of the trade which were presumed to be interesting to his forbears.

The development of more rapid methods in this country has been somewhat slow, and much of the mass-production work which has been undertaken in spasmodic leaps in other countries has not been experienced here. This is for the good of a trade well supplied with ample skilled labour, and this latter fact is no doubt the reason for the slow development of mechanical methods in this country. Another factor against rapid change of method as compared with, say, America was the high state of development we had reached 50 years or so ago whereby the requirements of the purchasing market were always fully met. One can readily appreciate that, had the production of castings been deficient in quantity or quality, there would have been greater inducement for engineers to apply high-production methods to meet the deficiency.

Foreign Developments

In countries developing engineering trades later than Britain, where no adequate supply of skilled labour existed to produce castings in sufficient quantity and of high quality, it was natural that a tendency to standardisation soon led to quantity production, which was in turn converted to mass production. In Britain the foundryman was in a position to offer a great variety of patterns to the engineer or architect, and this condition still remains to-day, and has probably been the greatest deterrent to quantity production. In countries where the engineer was less liberally supplied with designs, he was induced to make his own design and to make it so that it worked easily and under power conditions. The British foundryman is gradually developing along this line, and to-day many of our large foundries are running on mass production. In the eyes of some visitors from overseas, we must appear to be very far behind, but the experience of the slump through which we have been passing has shown the wisdom of gradual development.

No doubt the old foundryman of 50 years ago would think we had gone a long way from the conditions ruling in his day, and he would be inclined to remark that our development had taken away the individual interest in the finished article. Not so with the young man presently doing his daily job in the foundry and who is assisted by scientific methods in doing a good job with the least effort possible.

Real Progress

The foundry owner of 50 years ago, if told that we were producing castings which sell at prices very little higher than he obtained, while we pay wages, rates and taxes fully double those paid by him, would wonder at our ability to exist in business. He would be impressed with the light section of metal used to-day as compared with his product and also with the very complicated and intricate castings produced to almost precision dimensions.

One other factor which must not be overlooked in a retrospect like this is the great improvement in the strength and solidity of castings now produced. The ironfounder in the past depended on bulk for his casting strength, and the designer built on this basis. To-day the designer has reduced his section of metal on the assurance that at about half the former weight he is getting a stronger casting with our modern metal. Where 6/8 tons tensile iron satisfied the older generation, we can now give 14/16 tons as regular foundry practice, and are able to increase this when necessity calls for it.

In steel and non-ferrous casting great improvement has been made in the metal, and greater accuracy in dimension allows for reduced machining allowances to limits not dreamed of 50 years ago. Probably greater changes have been wrought in steelfounding during 50 years than in ironfounding or brassfounding, but I wish to direct more special attention to the ironfounding trade, and so pass steel and non-ferrous by, merely mentioning them.

Trend of Costs

I have been able to collect a variety of costs in several branches of ironfoundry work over a period of 60 years, and it is interesting to note some of the comparisons. It has been extremely difficult to reduce the variety of figures, which have been expressed in different ways and sometimes with insufficient interpretation to make them readily understood, but I have taken a liberal translation based on my own experience, so that the results are presented with reservations.

In the year 1874 wages absorbed only about 25 per cent. of the selling price of the castings produced, while in 1934 wages required almost 45 per cent. of the selling price. The cost of liquid iron in 1874 was approximately 18½ per cent., while in 1934 it was around 15 per cent. Pig-iron was slightly cheaper during 1934 than it was in 1874. No doubt, if we could learn the total 100 per cent. in 1874 and compare it with the 100 per cent. in 1934, we would find that the greatest difference would be in the profit earned, but that is beyond my inquiries. I have quoted these figures as an introduction to some remarks on wages and profits in the foundry trades.

In practice, we find that, say, 45 per cent. of the selling price consists of wages in the foundry department. When we consider our purchases of iron, we cover in that item the following:—Wages paid to iron-ore quarrymen, coal miners, railwaymen, blast-furnacemen, casters, and, again, railing of finished pig to our foundry. Similarly, we can consider coke, limestone, ganister, firebricks, plumbago, etc. In fact, what we are paying for pig-iron to-day is nothing more than the wages paid to the various workers in the many different branches which go to produce and deliver the iron to our foundry, plus on-cost, which again is made up to a large extent in wages of clerks, etc., rates and taxes, which are mainly used to pay wages for social and public service. At the bottom, therefore, we are buying so much service which has been paid for in wages expended in the production of pig-iron. If we examine this position and realise that to-day wages are roughly twice what was received for similar service 50 or 60 years ago, and pass this same increase into all the manufacture of our raw materials, it is astonishing how we are able to sell our finished-iron castings at prices roughly 45 to 50 per cent. over those charged three generations ago.

The profits made in the old days were very largely invested in developing the businesses in which they were earned, and one looks anxiously to see how the present foundries are to be developed and handed on to the next generation unless more reasonable profits are produced from which adequate depreciation and obsoletion charges can be allowed.

My investigations have led me into a wide range of foundry products and the conditions naturally vary very considerably, but to give an example of an actual case might bring out my point much clearer. I have been able to obtain the cost of a series of castings made in 1884 and a similar series of identical castings made in 1933 from the same patterns, in which no marked difference in method of production had been introduced. In fact, almost identical plant and conditions of moulding were used in both cases:—

	1884 Shop costs.	1933 Shop costs.
Total wages, including moulders melting labour, foundry labourers and dressers ..	1 1½	2 3¾
Weight of casting, 34½ lbs. each	—	—
Melted iron mixture—		
45s. per ton	0 8¼	—
60s. per ton	—	0 11¼
	1 9¾	3 3

The wages on this job have more than doubled, while the melted mixture of iron has only increased by little over one-third extra. It should be noted that during the year 1884 pig-iron touched its lowest recorded price of 40s. to 41s. 6d. per ton.

To complete these figures and show a finished cost, including increased rail charges, counting house wages, rates and taxes, is beyond my present purpose, which is to show that the economy in producing the melted mixture at so small an increased cost, despite the increased wages paid to iron-mine workers, coal miners, railwaymen, etc., shows that careful and efficient methods have been introduced.

E

It is obvious that an increase in selling price of only about 45 per cent. indicates one of two things:—(1) The profits in 1884 were very high or (2) alternative methods of manufacture must be introduced to continue in business. There is no doubt that the profit on castings sold in 1884 was very much higher than it is to-day, but owing to increased care to-day we are producing castings with greater certainty of their being good and saleable. This has a very marked influence on the finished-cost figures.

One hears many yarns of the wasters of the good old days, such as the story of a well-known foundryman of 40 years ago. This man had a reputation for good marine-cylinder castings of large size. Two large cylinders had been made and, turning out wasters, were scrapped. The third mould was prepared for pouring when "Big Bob" shouted out to the squad: "We have had bad luck with this job, but if this is a good casting I won't lose any money on it, so see to it." The difference to-day is in great measure due to our making better castings first time and cutting out wasters.

There is a point where jobbing work verges on to work which can be produced by machine. The one thing which decides the fate of a jobbing mould becoming a machine-made mould to-day is greatly different to that of 10 or 15 years ago. New methods of machine application have changed the outlook of foundry executives, and as the shop costs rise out of proportion to the selling price, jobs must either be lost to the foundry or be produced more economically. Increased rates of wages call for better employment of the time paid for at the increased rate, and if by cutting out the less-skilled part of a moulder's work and applying his genuine high skill as a moulder to real moulding, a great deal can be done to produce increased tonnage of castings at a still remunerative rate.

It must not be assumed that the foundry management sells his castings at prices apparently out of proportion to rising wage costs for any other reason than that he cannot get more for them. There is still a great deal of uneconomic price cutting just to get a job at any price, but that is only one aspect of the case. There are many young competitors to cast iron on the field to-day. Ferro-concrete has taken away much of the old heavy bridge-building trade, and it has entered successfully many branches of construction for which cast iron or cast steel would be preferred if the foundry could compete in price. Welded-steel construction has had a similar inroad on foundation plates, engine beds, and many purposes for which cast iron was used until recently. We are hopeful that the great increase in high-duty cast irons of various types will to some extent remedy part of this loss, but unless the foundry can so reduce the section of iron as to bring the finished article to competitive price level with welded products there is small hope of inducing engineers to revert to cast iron.

Pig-Iron Prices

In the year 1836, just on 100 years ago, pig-iron was selling at 125s. per ton. Ten years later, in 1846, the average price was 72s. per ton. In 1856 the price was 72s. 6d. per ton. In 1856 there were 154 blast furnaces in Scotland with an average of about 120 furnaces in blast.

I hope I have not struck a note of despondency. I want to bring before you the fact that, despite much criticism to the contrary, a great evolution has taken place in the industry during the past 50 years, even when we compare conditions pertaining in jobbing foundries which appear to be working much on the same conditions to-day as in the past. I have not touched on our modern machine-production foundries, as they have no counterpart in the trade of 50 years ago. Machine-production foundries have much to do with the low level of prices in the old hand-operated shop to-day, and as the introduction of machine methods increases so will the margin of profit decrease in these shops.

It is easy to look back 50 years on the records of those who went before us, but who is bold enough to look forward 50 years and hint at what a foundry may be like then? To the young men in the trade I wish to say that in my opinion no trade offers more scope for bright ideas put into practice, careful work being a necessity in the patternshop and equally in the foundry. The trade is one which should appeal to intelligent youth looking for a prosperous future. Do not be backward in proffering your ideas to those who can make use of them. Do not be content to be a sand puncher when you should be a moulder. Take advantage of all the means so liberally placed before you by the technical schools to make yourself worthy of the hardy men of the past who were not blessed with such an opportunity.

The trade has great need of willing and courageous young men. Make yourself one of those to whom your foreman will give the difficult job and recognise the honour he has conferred on you in placing his trust on your skill and integrity, and be ready for a more difficult one to-morrow.

MR. A. LAWRIE (Past-President), in proposing a vote of thanks to the President for his address, said that any who could cast their minds back 50 years and compare foundry conditions then and now found what enormous changes had taken place in that time. He thought the moulder of the past compared well with the moulder of the present time. The moulder of the past had none of the aids they had to-day, yet they made moulds as well as the men of the present. If some of the patterns which they used to get in the old days were put into the hands of the present-day moulder he would get something to think about. The foundry had to stand or fall by the profits it could make.

MR. J. LONGDEN (Past-President), in seconding the vote of thanks, said that the address had been intensely interesting and to some extent intensely provoking, but as a presidential address was not open for discussion he could not elaborate on that statement.

The PRESIDENT then introduced Mr. John McGrandle, who read a Paper on "Some Notes on using Metal Moulds for Cast Iron," illustrated by a large number of lantern slides.

Iron and Steel Production

The British Iron and Steel Federation, in its Statistical Bulletin for September, states that pig-iron production in September was 529,600 tons, compared with 543,400 tons in August and 500,300 tons in September, 1934. The decline is entirely due to the shorter working month, as the daily rate increased from 17,529 tons in August to 17,653 tons in September. The total for the first nine months of the year is 8.2 per cent. greater than for the corresponding period of 1934. Steel production in September was 855,900 tons, compared with 759,900 tons in August and 734,700 tons in September, 1934. The September steel production is the highest figure since October, 1929, and brings the total for the first nine months of the year to 7,220,300 tons, an increase of 9 per cent. over the corresponding period of 1934. According to returns received from 147 firms employing 116,658 workpeople, the average weekly earnings per head in August amounted to £3 2s., compared with £3 2s. 7d. in July and £3 in June.

SIR CHARLES CRAVEN, managing director of Messrs. Vickers-Armstrongs, Limited, speaking in Newcastle-upon-Tyne last week, said the Darlington Forge would be reopened immediately, and the plant brought up to date, if the present battleship replacement programme of the Government was decided upon.

Metallurgical Progress in the Foundry

(*Concluded from page 342.*)

MR. BURGESS asked whether we were coming to the stage when the foundryman would specify what blast and moisture should be used for his pig-iron. It used to be when the foundryman ordered Nos. 1, 2 or 3, etc., and then he specified analysis, and if things went on, he would soon be wanting his pig-iron wrapped in "silver paper." He had been interested in the moisture, and he had had the experience of laying down plant for drying the air going into the blast furnace, and when changes of atmospheric conditions came about, there were reactions which disturbed the running of the furnaces. In the blast furnace one had such a volume of material and gases, which reflected themselves in the analysis. The change of the moisture is given in the analysis. As regards coke, the foundry could pick and choose a little, but the blast

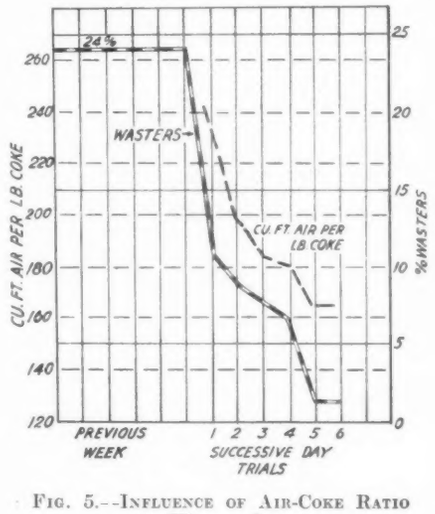

FIG. 5.—INFLUENCE OF AIR-COKE RATIO ON WASTER LOSS.

furnaces were in the position that there was hardly enough to go round. MR. DAWSON referred to combustibility, and that reflected back into the analysis. They had now discarded the drying of the blast owing to the cost.

Author's Reply

MR. DAWSON said the nuclei theory had been a good guide for removing slime by stirring in the ladle, and skimming. A worker in Germany also held metal at a temperature for eight to ten days, and found it to be an eutectic iron, free from slag inclusions. It was produced by allowing the graphite to come to the top and by skimming off as kish. He had started off in his Paper by saying that all the results were tentative and not as applied in the foundry, to start a line of thought bringing more light on the subject. When one knew more about them, founders would be able to apply them and control them. He did want to stress that all these investigations would be applicable in the foundry in the course of a few years. The type of trouble he had encountered when using the excess air was segregation of phosphide on the surface of the casting, preventing good machining of the castings, caused by oxidation of the metal. If one constantly oxidised, one would have to have different running methods to those in use to-day. The combustion of coke had nothing to do with the analysis. If one tried a dozen cokes, one would find different combustibility. He would rather have a coke with a suitable combustibility than analysis. Whatever had been done with cast iron, the same should be done with pig-iron. How could one expect to know about cast iron when one knew so little about the pig-iron one used?

The British Cast Iron Research Association

ANNUAL LUNCHEON

Major F. A. Freeth (President) presided at the annual luncheon which was held at the Hotel Victoria, London, immediately after the annual general meeting on Wednesday, October 30.

Mr. J. M. Kennedy (President of the Institution of Electrical Engineers) said the electrical industry, had as its main ideal the improvement of the conditions of living of the majority of the population in the country and in order to achieve that ideal it was striving to reduce the cost of electrical energy and at the same time to improve the quality of the apparatus used in the generation of electricity and, more particularly, to improve the apparatus in which electricity was used. The electrical industry was a young one in many ways but it realised, as did all industries, that research was a paramount necessity. Therefore, he welcomed the assistance of the British Cast Iron Research Association in that respect. It was not many years ago that the electrical industry had as its raw materials just ordinary copper or iron and bits of string and some shellac. That was all that was considered necessary for the electrical engineer. Nowadays, however, the electrical industry was almost entirely dependent upon the iron and steel industries. As regards cast iron, the electrical industry was fundamentally dependent upon the quality of the material in many respects. In the production of electricity the industry was dependent upon the quality of cast iron for the frames of machines, condensers, converting plant and all sorts of water pipes, conduits, tunnels, etc., for which high quality cast iron was essential. On the distribution side the quality of cast iron was probably even more important and the exacting requirements in regard to such apparatus as electric cookers, hot plates, irons and the multitude of other purposes for which cast iron was used were being met by the manufacturers of cast iron as regards mechanical strength, magnetic and non-magnetic properties, the absence of distortion under heat and so on.

Weldings

He gathered that welding had been rather looked upon by the foundry industry as a competitor in some respects and possibly that had been the case for some years but he ventured to prophesy that with the increase of knowledge of metallurgy and further experience of the possibilities of welding, the foundry industry would have nothing to fear and, indeed, welding might prove a very valuable ally to the foundry.

Mr. J. G. Pearce (Director of the Association) read a letter of regret at his inability to be present on account of the General Election from Mr. Ramsbotham (Parliamentary Secretary to the Board of Education in the Parliament just dissolved) in which he spoke of the Association's Foundry School and the collaboration of the Board of Education in its establishment.

PRESIDENTIAL ADDRESS

A £40,000,000 Industry

The President then gave a short address, in which he said:—In the year which has just closed we set out to raise from your industry a subscription of £7,000, which was required to qualify for a grant from the Government of £5,000. Well, we have done it, but, as the Duke of Wellington said about the battle of Waterloo, "it was a close-run thing." For subscriptions that we raise over £7,000 the Government have promised us £ for £. We have set ourselves out to get an income of £20,000 per annum, and when you consider the turnover of the foundry industry, which is in the neighbourhood of £30,000,000 to £40,000,000 a year, this sum cannot be regarded as extravagant. There is £1,300 on account of fees from the balanced-blast furnace cupola, and it is with great satisfaction that this amount has been earned and applied to meet the cost incurred in the installation of this cupola.

The Association is working on the melting quality of various cokes, and the addition of natural clay to sands. This latter point is of the greatest importance, in view of the increased tendency towards continuous production and mechanisation of foundries. As regards the metal itself, the Association has appointed a special man to deal with shrinkage and contraction.

The new process of graphite refining has already attracted a great deal of interest, and we have done some very useful work both as regards fine grain and coarse grain. The fine-grain process is already covered by patent. To molten pig or cast iron a small quantity of titanium is added. The metal is then subjected to a treatment by an oxidising gas for a determined period, and in this way one can convert high-carbon pig, cast iron or even scrap iron into a material having the graphite in an extremely finely-divided form, as finely divided as, in fact, it is possible to obtain graphite in cast iron even under the most difficult experimental circumstances. We do not know yet quite why we are doing this, but we are doing it. The Association also discovered how to reverse the process, *i.e.*, it can make a cast iron which originally contained a fine graphite into a material with a coarser graphite, which is useful under certain circumstances.

The Iron and Steel Industrial Research Council is helping in the work of producing fine structure in ingot moulds and to ascertain the effect on the life of the castings, and it is working in the closest co-operation with them. It is also studying the effect of other elements upon cast iron such as copper, molybdenum and aluminium, and I happen to have a very intimate knowledge of an aluminium-iron which has been invented by my old friend, Mr. Peter Sandberg. At the Iron and Steel Congress in Brussels last year a Paper was presented upon the properties of an alloy containing 15 per cent. of aluminium which stands up to oxidation in a way never before thought possible. It almost behaves like a noble metal.

The Association is also working in cordial co-operation with the National Physical Laboratory, particularly on subjects such as creep strength and the resistance of cast iron under combined flexural and torsional stresses. The first results of this latter investigation are being presented on Friday next to the Institution of Mechanical Engineers.

A Study Course

Two years ago Mr. Pearce, our Director, had a brain wave and suggested that he should organise a three-days' study course at our headquarters, and the Association was surprised and delighted, but a little horrified by the fact that no less than 150 members turned up and to a certain extent it was swamped. I think that is a practical testimonial to the kind of work we are doing and we are going to do a similar thing on November 6, 7 and 8.

The Director

In Mr. Pearce we have a Director who, apart from his genius for research and scientific initiative, combines that necessary chameleon-like quality of juggling with finance—I do not know that "juggling" is the right word—and the thousand and one household cares which beset the modern Director of Research. The first time I went round your Research Department I was impressed by the manner in which he made £1 do the work of £2, and the economic and efficient manner in which members get the most for their money.

New Plant Wanted

When I first spoke to you before you made me President, some three or four years ago, I was urging upon the Association the necessity for buying an electric induction furnace. At the time trade was bad, but, as you know, trade is now very much better, and still we are without our induction furnace. Then there is another matter. The other day I was quite casually in the establishment of a very famous firm of opticians, when I saw a projecting microscope which had rather a familiar appearance to me. I found that this very projecting microscope was the one loaned to our Association for the exhibition which we held in conjunction with the Department of Scientific and Industrial Research at Olympia. That microscope costs about £250, and it seems to me that somehow or other this money should be raised. The induction furnace is a much bigger matter, but I again commend it to you, for, if we had one, we could quadruple the speed of our work.

I should like to emphasise the cordiality and reasonableness with which the Department of Scientific and Industrial Research has met us on all points. The Department has treated us with the greatest generosity and consideration. It is difficult under any circumstances to organise research, but when it is organised by the Government, it becomes still more difficult. Nevertheless, there is a great deal of nonsense talked about lack of Government co-operation, and it is all wrong, and the greatest possible help has been given during the past year. The essential nature of research lies in individual thinking; all great and original thinking is essentially individualistic, and here is where the paradox comes in.

The Foundry School

We have started, as you know, a Foundry School with the object of training young men to be better founders than they otherwise would have been. We have deliberately set our faces against that doctrinaire system which obtains in some institutions and countries. We have said to ourselves "We will take a young man who has a natural flair for founding and we will not exactly train him but we will put material before him to bring out the aptitude which will be part of him and make him a useful founder. The object of our school is to help people to help themselves. The best training in the world is obtained by sitting at the feet of a master, but there are so many people who want to be trained that there are not enough masters to go round. The second best is what we are able to teach ourselves, and that is the object and aim of the Foundry School.

Col. A. E. Davidson, D.S.O. (President, Institution of Mechanical Engineers), proposing a vote of thanks to the President, said he had seen considerable improvement in foundries and most noticeably in the lighting. He had been largely engaged on automobile work where, trying to reduce weight, light alloys had ousted cast iron to a considerable extent, but there had been a great counterstroke in the development of the use of the cast-iron crankshaft, which he was well aware would run in bearings that were considerably out of line far longer than shafts made of alloy steels. In engines which must be cheap in order to sell, there was an unfortunate tendency for the production side in which easy machinability was an outstanding virtue, with the result that wear was unduly rapid and cast

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System in the Selling of Castings*

By E. N. SIMONS

There is a great difference between the methods which the modern founder must adopt and those considered satisfactory 50 or even fewer years ago. In the old days selling castings consisted mainly of collecting together a number of miscellaneous people called foundry salesmen, giving them a certain salary and certain expenses, or sometimes no salary and no expenses but a fairly liberal commission, and sending them out into the highways and byways to get orders. All that was demanded of those people was that at certain periods there should be received from them batches of orders for steel castings. The market for steel castings was mainly a question of the impressions received in the various centres by the travellers. To-day we are faced with the position that the buyer is not nearly so much buying on his own account as he was 100 years ago. This is largely due to the fact that the scale of business has been considerably magnified. There are fewer buyers to-day, or if there are not fewer, the more important of them to-day represent large-scale organisations. There is a tendency for the amalgamation of these organisations to continue, and the buyer is now less than ever in a position to gratify his own particular likes and dislikes. Always behind and above him stands an entirely impersonal system which demands of him facts and figures upon which his own value to the firm depends. He can never, for the sake of personal friendship, pay an unnecessary shilling a cwt. more for a certain kind of casting, because behind him is always the cost accountant wanting to know why the costs of production have gone up. While within certain narrow limits it is still a fact that the salesman with a pleasing personality will produce more results than the salesman not so endowed, there is a definite narrowing of the margin, and the buyer is more and more compelled to demand of the salesman a casting that is technically perfect and satisfactory in price and delivery. It is only after quality, price and delivery are satisfactory that personal friendship can begin to play its part.

Creating a System

The modern salesman of castings has got to face the fact that approach to markets must be very much more systematic than ever before. If the analysis so far made be accepted, the question arises: Where does this system begin? In other words, in what way is the approach to the marketing of a firm's castings to be systematic? How can one begin to systematise with a view to transferring one's goods to the works of the consumer? Fundamentally, all this question of marketing castings and selling castings is a problem of transportation. It is a problem consisting of knowing one's output and estimating how it can be transferred from the factory to the factories or the machines of the consumers.

Sales Analysis

In the modern world that transference of a firm's product to the works of the consumer has got to be systematic or it is doomed to fail, because business is on such a large scale to-day that unless a certain percentage of sales of the output can be guaranteed in advance, it is doubtful if the business will prosper. The most important step of all is "sales analysis." It is the root of the whole problem of marketing castings systematically. To sell castings of any kind, the first step to attack a market systematically is to take existing customers as the basis. It must be insisted that the sales department provides every day throughout the year, over a period of years, a complete list of orders for castings. That is to say, every firm must be listed with the type of castings ordered, and if possible the weights, or quality, or prices of the castings. That information, presented every day, constitutes the basis of sales analysis. Having secured this information, the names and addresses of the customers should be placed on cards in a card index, and classified according to the type of castings they were purchasing. There would also be recorded on these cards the particular type of industry the various firms represented. For example, supposing it was found that the castings could be divided into work for railway work, for switchgear and numerous other types of castings, it would be ascertained which of the customers were switchgear manufacturers first of all.

An Example from Switch-Gear

Having discovered from the order records that a percentage of, say, 50 of a certain class of customers were switchgear manufacturers, it is not an unfair assumption to say that switchgear manufacturers can use castings—whether iron or steel is immaterial at the moment. Having got that far, there is a definite fact of sales value. It is known that switchgear manufacturers use castings. The first use to be made of that information would be to collect as many directories and lists of switchgear manufacturers as possible. From these lists existing customers would be eliminated, leaving a residuum of switchgear manufacturers who were not customers. Thus there is an ascertained market, consisting of the names and addresses of, say, 40 people who are not customers for their switchgear. The sales manager can now go to his representatives with a definite fact. He knows there are 40 switchgear manufacturers from whom he is not receiving orders or inquiries. The next step is to transfer the problem from the brain of the sales manager to the bodies of his representatives. Instead of instructing the representatives on Monday morning to go to the ends of the earth and get orders, each representative is informed that there are such and such a number of switchgear manufacturers in his district from whom the firm is not receiving orders. They must be visited and the following information obtained: (1) Whether they are using or could use the firm's castings; (2) whether they would, under any consideration, place their orders with the firm. This involves, first of all, that the salesman has been given a definite market to attack. Secondly, it affords a measure by which the value of a salesman can be estimated. If A has five switchgear manufacturers in his district, and as a result of the providing him with this information he gets orders from three new customers, whereas B, with a similar number in his district, does not get any orders from the list you give him, there are grounds for assuming that A is a better salesman than B.

Thus, through sales analysis, one is all the time acquiring information about the markets and about the salesman. This is obviously a thoroughly sound method of business, but it is strange how few people are practising it.

The Second Phase

The compilation and maintenance of efficient sales records are essential, which is largely a question of organisation. This work is a comparatively simple matter from an organiser's point of view. There is, first of all, the question of what should be recorded. In order to minimise clerical work, the amount of data to be recorded should be reduced to a minimum. Every potential customer should have a record sheet, on which should be recorded (1) the date of any orders or inquiries received; (2) what the orders and inquiries were for; (3) the dates upon which quotations were made; (4) the dates of the travellers' calls; and (5) a *précis* of the purpose of the call, the substance of the discussion, or the customer's comments on the quotations made (Fig. 1).

Date.	Product ordered.	Inquiry.	Date of quotation.	Representative's call.	Comments of salesman.
6/10/35	Switchgear castings	9/10/35	—	10/10/35	Price too high.

FIG. 1.—EXAMPLE OF SALES RECORD SHEET.

Using Sales Records

The whole of this information can be compressed into a very small space. Now that record depends for its accuracy upon a systematic method of forwarding the information to the recording clerks. That means that all the clerks must have also their lists of orders. They must see all the representatives' correspondence and all inquiries. That system is actually working in practice, and is found quite satisfactory. It involves that at certain periods of the day the whole of these particulars are gathered together and delivered to the sales records clerks, who compile the data from them. It may be thought this is a very elaborate organisation, and its benefit queried. However, it has first of all an internal benefit, quite apart from the question of selling castings. It has been found that, by having such a condensed sales record for every customer, one can ascertain the whole of the negotiations with a certain customer over a period of years on two or three sheets, kept in a central place. People can go to that central place at any time, and get immediately the information they want. A great deal of time is saved by this system. From the sales department's point of view, the ability to see in front of them the whole sales history of a particular firm when they are making a fresh quotation is almost impossible to over-estimate.

Dormant Customers

It frequently happens that a firm may not send any orders for a period of two or three months. No one notices the absence of these orders unless they happen to be very large customers. Then, perhaps, an inquiry is received, and, oblivious to what has happened previously, a sales clerk may send a letter ignoring certain discussions that have taken place, thus causing friction. Now, under the system outlined, the sales clerk or sales manager making the quotation, on receiving the inquiry, sends for the sales record sheet. He knows from that the price quoted in the past. He knows whether, on the last occasion, the order was lost because of price. He is then able to frame a quotation embodying a complete knowledge of everything that has gone before.

Another direction in which these sales records are of enormous advantage is in reviving accounts which are dormant. It would be a physical impossibility to take the whole of a founder's order-books and go through them to see which firms were not ordering. With the sales record sheets it is perfectly easy. In one system at present in operation, one member of the sales department goes through a certain section of the sales record sheets every week, and picks out the sheets appertaining to those firms who have not ordered over a given period. With the help of these sheets he is able to ascertain why they have not ordered. Usually, there are a number of people on whom the representatives have not called for perhaps six months, and from whom, as a consequence, no orders have been received. A member of the sales organisation collects the record sheets relative to these dormant accounts, and proceeds to write to the representatives of the areas concerned, asking

* A Paper presented to the Sheffield Branch of the Institute of British Foundrymen, Mr. J. Roxburgh presiding.

the representatives if they are going to call on the firms within the ensuing few weeks, and stating that otherwise it is proposed to write special letters to them.

Reminders and Their Analysis

Every week a number of these special letters are sent out to these firms whose accounts are dormant. These letters are carefully worded and read something like this:—"It is some considerable time since we had the pleasure of receiving an order from you for such-and-such castings. We hope that the castings we sent you last (date here) proved entirely satisfactory, and should like to know if there is any reason for your not having sent any further orders."

It has been found in practice that 10 per cent. of these letters bring fresh orders. That is a fairly good proportion. Another 10 to 20 per cent. of the firms write that they were perfectly satisfied, and that the only reason they have not placed orders is that just at the moment they have none to place. Some 7 per cent. write that they have not sent orders because they were not satisfied. In 5 per cent. of these last cases this is the first time the complaints from the firms concerned have been heard of. At once there is something to go on. When these people have a complaint, there is something to write to them about. Regrets are expressed, and they are assured that it is merely a matter of arrangement, and attempts are made to re-establish their confidence. In most cases this leads to a removal of the customers' grievance. That is systematic selling.

Sales Promotion

There is another systematic method of selling, that of "sales promotion." One aspect of this consists in getting in first. Obviously, this sounds a very tall order, but there is the fact that castings are not sold by trusting in providence. One of the best ways of selling castings is to get information before the man next door. If one knows or can find out that a particular scheme is afoot in which, inevitably, castings will be used, one can pass that information on to the man on the spot entrusted with the job of getting orders. One has then practically stolen a march on the other fellow, and should be well in the running for the major share of the business. One of the ways in which that can be done is to go through as wide a range of technical, trade, and daily journals as possible and extract the information which appears therein. In one case where an obscure paragraph appeared in a paper which very few technical people read, a paragraph was spotted by a sales-promotion department. It simply stated that in a certain Crown Colony the cost of imported cement was so high that there was a scheme afoot to put down a native cement plant. It is well known that there are considerable numbers of castings required in machinery for cement plant. The minute that little obscure paragraph was read by the sales-promotion department, steps were taken to approach the financial people in London and the Crown Colony interested in the scheme, and the upshot was an inquiry for castings running into a very big figure. Whether or not the order was obtained is immaterial. The point is that, by having somebody in an organisation whose job it is to examine for information of sales value and see that it is passed on to the people who can turn it into orders, the firm is attacking a market systematically.

Basic Information Supplied

Another method of systematically attacking markets is to see that the representatives have all the information they possibly can about the firm and its castings. The representative who calls upon a customer and immediately he is asked a question out of the region of his practical knowledge, says he does not know, and has to refer it to the works, is unsatisfactory, but not entirely to blame. It is not always possible to send an expert technical man out on the road. Sometimes, willy-nilly, one has to send out a man who is not himself a foundry expert. But if it be decided to send that man out, surely if he is not in the position to answer ordinary questions it is to some extent the firm's fault for not having supplied him with the information. One way in which this is tackled in America is by sending out what they call sales bulletins. That is a good method but not quite adaptable to the English temperament. Instead, in the author's firm, there is what is called a representatives' price book. In addition to all the standard prices that can possibly be given, it contains a great many details. For example, there are particulars as to the size of the foundry, its maximum potential output, the type of castings it produces, the way castings are treated before despatch, and any other facts that it is thought the salesmen should know or may need when selling castings. Those facts are given in a form perfectly compact, and the book can easily be slipped into the coat pocket. There is in vogue a system of revising the particulars as they become out of date. The book has been a great boon to the representatives, because they no longer have to write to the works for every small piece of information. They have only to glance at their books and the information is there.

Dealing with Quotations

When the average foundry receives an inquiry from a customer for castings, the inquiry is pinned to the file copy of the quotation, and this goes into the file, where it lies. If an order does not ensue, the quotation remains in the file, and will not be removed until the end of the year, when it is probably transferred to boxes. Every quotation represents a potential order, and the business of a salesman or managing director or whoever is responsible for selling castings is to see that if a quotation does not result in an order, steps are taken to find out why. Personally, the author would not file any quotation until he knew why he had lost that order. In general, every quotation represents an opportunity. It means that by a sales effort the interest of some firm has been aroused sufficiently to make them think you can supply their needs. No quotation should be filed until either from the representative or by direct letters it has been found out why the order has been lost. When the reason has been ascertained the quotation should not be filed until an effort has been made to do something at the foundry end to avoid losing such orders in future. If a large percentage of the quotations result in the complaint that the price is unsatisfactory, there may be something wrong with the methods of production. It is fundamentally bad to quote and forget all about it. There should be systematic analysis in every case of the reason for losing orders, and the representatives should be instructed to find out and report as far as possible why orders are lost.

Overseas Markets

The author has been impressed by the apathetic way in which people regard their overseas selling. To the question "Do you get any export trade?" the average foundry owner will reply: "You cannot get export trade to-day, with restrictions here and prohibitions there." There is found amongst English people too great a readiness to assume that one cannot do a thing because it happens to be difficult, and particularly is this the case with overseas trade. It is postulated that while, at the moment, there may not be a market for castings in some overseas countries because the world is covered by a network of trade restrictions, it does not follow that this network will continue indefinitely. When those restrictions are removed, who is going to get the business—the people who have neglected the overseas countries or those who, through good times and bad, have paid them the compliment of sending representatives of standing? It is definitely bad and unsystematic to refrain from sending representatives overseas because on one particular trip they cannot get as many orders as would be liked. The tendency amongst founders is largely to neglect overseas business. There is also room for greater discrimination in the type of person sent overseas. One does not wish to be snobbish, but there are cases where persons have been sent to India without having what one might call adequate social standing. While one may regret that in certain countries a certain social standing is necessary in order to enable one to mix with the people who matter, one has to face the fact that there are such countries, and India is one of them. If a man is sent to India who feels uncomfortable in a boiled shirt, then the best representation is not being given. On the other hand, to send a highly aristocratic, stiff and starchy person to Australia or New Zealand, where he is expected to be hearty and hail-fellow-well-met, is again a mistake. Yet the wrong types of person are constantly being sent to these various countries. Overseas representatives should be chosen to suit the particular countries and markets.

DISCUSSION

Cost of Sales Department

MR. J. ROXBURGH expressed appreciation of Mr. Simons' address. He agreed that the question of the best means of selling castings could not be stressed too much. He felt that, after those concerned in the works had spent many hours, in some cases, over the compilation of an estimate, the sales department should exert every effort possible to ensure the securing of the order. On the one hand, it was reassuring to the works man to know from the representatives' reports that they were competitive, whilst on the other hand it would be useful information to the works man to know why they did not receive the order for castings for which they had quoted. The works man was naturally interested to know when an order had not been received on account of the price being too high. He would begin to consider whether the other firm had better facilities, or smaller overhead charges, or some other advantage that his firm did not enjoy. Such an investigation was good for everyone concerned. He was afraid that in the olden days works people were apt to look upon the sales department as composed of people who took the quotations forward with them, royally entertained the prospective customers, and, if they possessed the right personality and created a good atmosphere, they returned with the orders. He wondered if Mr. Simons had extracted information showing the percentage of orders received of the quotations made. He had had such an extract made some years ago, and the figure was round about 5 per cent. He wondered, also, if Mr. Simons had taken into consideration the commercial aspect of selling castings from the standpoint of the actual cost of the sales side compared with the value of the orders obtained, and if the extra expense involved in the system indicated was justified viewed from this angle.

Dormant Accounts

MR. SIMONS said he had not the figures that the chairman had referred to, though he believed they had been got out by the sales department. He was quite certain that the percentage of extra sales cost represented by the organisation he had outlined had been more than outweighed by the beneficial results obtained. They knew from the percentage of new customers they made and from other indications he could cite that the organisation produced results. They had definitely ascertained that 10 per cent. of dormant accounts—accounts that had lapsed—had been reopened by their system. By keeping a close and systematic watch on the lapsed accounts alone, they were helping the salesman and the firm. The cost in comparison with the advantages was infinitesimal.

Overseas Markets

MR. S. LEETCH said Mr. Simons' emphasis upon the need for nursing the overseas markets was very sound. When a firm was able to negotiate for a big order through detecting an obscure paragraph in a paper it proved that the system was well worth while.

Personality in Salesmen

MR. ARNOLD CARR said it was particularly interesting for him to listen to Mr. Simons' address, he (Mr. Carr) being sales manager on the one side and a buyer on the other. It was very gratifying to find that for once in a while the man who sold something was given credit for having a little more than normal *savoir faire*. The average impression apparently was that a salesman is a well-dressed fellow who uses a Rolls Royce car, lunches and dines well, and is the "hail-fellow-well-met" kind of man. Actually he was a far different type of person. It was his experience that the best method was that of sending certain definitely-appointed men regularly and systematically to fixed areas. If a man worked his area thoroughly, although he might not be as brilliant as the man in the next area, he would probably register as much or more business in his area than the ultra-smart man in an adjoining area who did not "get down" to the job to the same extent. At the same time, however, despite Mr. Simons' remarks about the modern buyer having no heart or soul, the personality of the individual salesman still counted considerably for the reason that if a man could not "sell" himself how could he expect to sell his firm's products? A man had a better chance as a salesman if his customers liked him, and would be more likely to get an order than a man whose personality was not liked, subject, of course, to price, quality and other conditions being equal. He thought they could not stress the importance of personality in a salesman too much. He must have neither inferiority nor superiority complex, but must endeavour to steer a middle course in this respect. He agreed with Mr. Simons in his observations about overseas trade. In many instances this trade was neglected. Often the wrong men were sent out. One could not put a "square peg" in a round hole and get satisfactory results. He expressed the opinion that a principal of a business was very often the most satisfactory overseas salesman owing to his position enabling him to make a decision on the spot.

The Buyer's Position

MR. SIMONS said he did not think he had declared that a modern buyer had no heart. What he did say was that the time had gone when a buyer could place orders with a salesman simply because the salesman had an attractive personality. All things being equal, or nearly equal, the man with the attractive personality would get the business. At the same time, conditions of business to-day were such that a buyer in a big organisation dare not pay more than he ought for goods simply because he was entertained. They all knew the kind of representative they hated the sight of, but if they were honest, they had to suppress that dislike and examine what the man was offering. If a man with a more attractive personality came along with identical goods on the same terms, then they would undoubtedly give him the business. That was perfectly understandable. So close attention was paid to production costs to-day that behind the buyer was always the shadowy figure of the cost accountant or the board of directors, who wanted to know why costs had gone up.

The Works—The Factor

MR. F. WHITEHOUSE said he was beginning to wonder what proportion of orders the sales department ever got. There seemed to be some suggestion to fix the proportion at 10 per cent. How many orders did they really get even through the most efficient salesman? Price and quality seemed the dominant factors, and salesmanship only a fairly useful addition. He could regard the salesman as a very great help in going into the world to discover what the buyer wanted, but he believed it was the works that sold the goods. He thought that the salesman was useful in so far as he went out and discovered exactly what firms were wanting. He helped to find an outlet for the facilities for production that existed at the works. Unfortunately, so many salesmen went out without any specialised knowledge of the foundry. A salesman was not of much use unless he had a fairly highly specialised and technical knowledge of the goods he was trying to sell and the precise advantages his firm had in the production of those goods.

MR. SIMONS said that in one way Mr. Whitehouse was correct. It was, in the ultimate analysis, the works that sold the products. Unless the works were selling good articles, the salesman would not be able to sell them; but fundamentally foundry firms were in competition with others, and the salesman and the sales department, in the peculiar conditions under which industry was organised to-day, had to go out and persuade buyers to give them the chance without which the works could do nothing. The object of a sales department and the object of all publicity was to make known the things that the works could do. Although the works might make a perfectly good product, the service who made that quality known was the sales department.

Works Executives to Travel

DR. C. J. DADSWELL, B.Sc., said that one was sometimes inclined to think that questions referred to the works by the sales department were rather childish and a waste of time, but this was not so. In large works where the representatives were not only selling castings, but forgings, and many other products, they could not be expected to know all the technical details, especially at times when castings were required for a new product which probably had not been previously asked for in a particular district. Every sales organisation should adopt methods for collecting data and feeding its representatives with information for future times. There was one point upon which Mr. Simons had not touched and which he (Dr. Dadswell) thought was important. He thought it was a good policy for the foundry manager to go out with the representatives occasionally. There were times when the sales department received complaints, but their representative, by his personality as a salesman, was able to find a way of reopening business; there were, however, other times when the salesman receiving complaints could be materially helped by the presence of the works man. Very often relations could be very much improved by the presence of the foundry manager, who could explain from a practical standpoint the difficulties that had arisen. Often the matter at issue was one of design and the matter could often be adjusted, so that a further order followed, and relations were re-established, things being put on a better footing altogether.

MR. SIMONS agreed. He was strongly in favour of the works man going out. He would outline as an ideal selling organisation a system of co-operation between the salesmen and the technical men. He would have the salesmen proper—that is, the ordinary representatives, who need not necessarily be technical men in the highest sense—men of good personality and good address who could pave the way. He would then have what he called a "flying squad" of technically-trained men, who were not perhaps in major responsible positions in the works, but who had technical knowledge and experience, to go out with or after the salesmen and follow up. He believed the time was coming in foundries when the ordinary social representative without technical knowledge would cease to be, and foundry salesmen would have to be trained in the works in order to obtain really good travelling positions. His own view was that a foundry salesman should begin his career in his own firm's drawing office, and go through the shops. There ought, in fact, to be a proper system of training for the foundry salesman. He did not believe in angling for some other firm's salesman because he happened to have pulled off a nice order for their competitor. The wise method was to look out for intelligent youths in their own works, start them in the drawing office, give them training all the way through in the practical work, and then start them out as juniors under a senior salesman on the road. In that way a really good sales force would be built up.

Follow-up Letters

MR. BERT WINTERTON said that at one time at the works with which he was associated they had a system of follow-up letters and second follow-up letters, but they dropped it because they found it was unsatisfactory. They received less than 5 per cent. of replies to their first follow-up letters and less than 2 per cent. of replies to their second follow-up letters. Nowadays they sent their representative on the ground to see the people and offer them, if they required it, without trying to teach them their business, the assistance of a practical man who was perfectly skilled in the use of the particular material they wanted. He would like to know which Mr. Simons would consider the better method.

MR. SIMONS said he had never hitherto found anybody who had adopted a systematic method of follow-up inquiries in the manner indicated by Mr. Winterton. Of course, he was unaware how much time and energy had been put into the job, but he felt that if they got 5 per cent. of replies they had something to start upon. Before he could give a definite answer to Mr. Winterton, he would want to have information as to what the follow-up letters were like and when they were sent out. A great many factors might enter into the reason for the small percentage of replies received, but he was still inclined to think that the trouble was worth while if only 5 per cent. of replies were received. If the thing was properly systematised, however, he felt they would get more than 5 per cent. of replies.

Proposing a vote of thanks to Mr. Simons, MR. E. J. BROWN said that from Mr. Simons' address it would appear that the salesman had to be a psychologist and a technician. The demands upon the salesman's qualifications seemed to be very high. He was afraid that at the works they were often too much inclined to look upon the sales staff as an encumbrance.

A vote of thanks was accorded to Mr. Simons, on the proposition of MR. E. J. BROWN and MR. F. B. OLLERENSHAW.

Catalogues Received

Mould Dressings. A leaflet received from the St. John X-Ray Service, Inc., 30-20, Thomson Avenue, Long Island City, New York, U.S.A., makes a series of claims for properties of Bonis, a proprietary powder for die coating and mould dressing.

Giratory Riddles. A four-leaf pamphlet received from O. N. Beck, 11, Victoria Street, London, E.C.4, describes and illustrates a line of electric sieves. These are filled with dust-proof totally-enclosed flanged motors running in ball bearings. The motors drive through a steel shaft a cam located in a housing. The cam, which also runs in ball bearings, keeps the machine in constant vibration. In order to prevent the vibrations reaching the motor, an elastic couple is inserted between the driving shaft and the shaft of the motor. The machine is available in several types, and can deal with foundry sands and liquids such as enamels. A special feature is the insertion of a self-rotating three-armed brush.

Vitreous Enamelling Section

DEALING WITH PAPERS PRESENTED TO THE INSTITUTE OF VITREOUS ENAMELLERS

Development of the Continuous Vitreous Enamelling Furnace*

By W. MARSHALL (Managing Director, Ferro Enameling Company (England), Limited)

Vitreous enamel is a glass similar to ordinary window glass, except that its ingredient composition is somewhat more complex in that it must adhere to metal and have certain other physical properties not necessary in ordinary glass. Vitreous enamel is applied to the base metal by either of two processes, dry or wet. In both, the enamel itself is basically the same, the process difference being the method of application to the base metal.

These two processes are both widely used to-day, the dry process being confined to the heavy cast-iron field, the wet process to the lighter and smaller castings and sheet iron. The final step in the application of vitreous enamel to the base metal is the fusing of the enamel on the metal, and this is commonly called burning. It involves the use of heat; thus a furnace for heating the base metal and enamel to a temperature sufficient to fuse or melt the enamel on the metal. Such a furnace, in addition to supplying the necessary heat to reach the fusion temperature, must also perform in such a way as to develop the maximum adherence of the enamel to the metal, and bring to its best advantage further physical qualities, such as toughness, resistance to shock, gloss, and surface texture.

Sheet Steel Baths

The high temperatures encountered in burning fuel present the greatest number and variety of design difficulties, and vitreous-enamelled sheet-iron parts to-day are rapidly decreasing the demand for cast-iron parts for enamelling. Examples of this can be found in the all-steel enamelled gas and electric cookers, all-steel kitchen sink, all-steel washing machine, and last but not least the all-steel vitreous-enamelled bath. During the author's last three-yearly visit to America this has become very noticeable, and in France, Belgium, Norway and Germany he has noticed that designers are continually changing the heavy cast-iron parts which gave enamelling difficulties for steel parts. The same trend is creeping gradually into Britain to-day.

The increasing use of vitreous enamel on sheet iron, and the difficulties encountered in handling modern fabricated sheet-iron parts, together with the necessity of reducing costs to permit vitreous enamelling to compete with other protective and decorative coatings, has led to the industry demanding a continuous furnace. Such a furnace has to improve the quality of the ware, decrease scrap, lower the manufacturing cost and increase production, and, at the same time, fit into new or old plants and utilise their available floor space and auxiliary equipment.

Furnace Development

The first furnaces to be built for the enamelling of household appliances were the full-muffle type, fired with coal. The muffle was a refractory shell within the furnace proper, separating the working or burning chamber from the combustion chamber. The purpose of the full muffle was to prevent the products of combustion from coming in contact with the ware, because ash, sulphur in the coal and reducing gases of incomplete combustion were detrimental to the finish of the ware.

In the early part of the twentieth century oil and gas were introduced as fuels. Because of their definite advantages of cleanliness and ease of handling, and because more heat could be developed within the furnace, they were quickly adopted. Fireclay was the only refractory available for muffle and combustion-chamber linings, and the more intense heat materially reduced the refractory life.

With these cleaner fuels available, and their faults to be overcome, a new design, the semi-muffle furnace, was introduced. The semi-muffle furnace was quite similar in general design to the full muffle except that the complete muffle arch and a portion of the muffle side walls were removed. Combustion was completed under the bottom, and the hot gases passed up behind the short muffle sides and were directed against the main walls and arch, and then passed out above the ware through flues in the roof.

Full-Muffle Type

In the full-muffle type the flue gases were necessarily several hundred degrees higher in temperature than the temperature within the burning chambers because of the low heat conductivity or thermal resistance of the thick fireclay muffle sections. With the semi muffle this temperature difference did not exist to such an extent since the flue gases were introduced directly into the burning chambers above the ware and since the gases came in more direct contact with the ware it was not necessary to force the furnace as much, and the refractory life was somewhat longer.

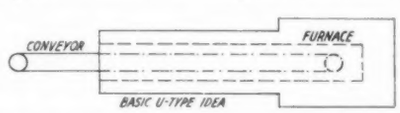

Fig. 1.—Diagram of Vitreous-Enamelling Furnace of the Continuous Type.

This type of furnace enabled them to utilise the new fuels, oil and gas, more efficiently, and increase production, but the control of furnace atmosphere caused trouble. Sulphur in the fuels and incomplete combustion periodically encountered were detrimental to quality, which was then becoming an important factor. So a new furnace, the intermittent-fired type, was introduced.

Intermittent-Fired Furnaces

The intermittent-fired furnace was introduced to give all the advantages of the semi muffle without its disadvantages, using the new fuels. The muffle was entirely eliminated, and burners were fired directly into the burning chamber while empty, and heated the entire interior mass of the firebrick shell. As the door was raised to receive a charge of ware burners were shut off, and with the door open and stack draft, the chamber quickly cleared itself of combustion gases. The ware was then introduced, and the heat stored up in the interior shell was sufficient to burn it. As the ware was removed, and the door closed, the burners were turned on to heat the interior for the next charge.

This type of furnace gave an atmospheric condition comparable to the full muffle and the speed and refractory life advantages of the semi muffle, but created a condition whereby the cold ware was introduced into the burning chamber at its highest temperature, and was burned on a reducing temperature cycle. This caused the thin enamel coating to heat up to its fusion temperature faster than the base metal on which it was applied, and tended to alter certain physical qualities highly desirable in the finished ware. For lighter gauges of ware, such as pots and pans, this fault was not serious, and several of these furnaces are still in use for this class of work.

All features considered, the full-muffle type, oil, coal or gas fired, was the desired furnace if refractories could be found to withstand the punishment. Maturing temperatures of enamels have been reduced somewhat, but not sufficient to overcome the refractory troubles. Better refractories, capable of withstanding higher temperatures, were needed, and silicon carbide and fused alumina were found to be particularly adapted for higher-temperature refractory use, and, further, were found to possess high mechanical strength and extremely high thermal conductivity. They were soon made available in standard-brick sizes, as well as tile, considerably thinner than the old fireclay tile, and were termed super-refractories. With the use of these super-refractories and the introduction of oil and gas as fuels together with improved muffles, there was developed the modern box-type full-muffle furnace in its present efficient state.

Continuous Furnaces

About twelve years ago, in America, several designs of continuous and semi-continuous furnaces made their appearance. Electric heat from ribbon resistors was then available, for industrial use, and because of the ease of application and comparatively low thermal unit cost, electric heat was used. Within a period of four years after the installation of the first U-type furnace, thirty-one more were built for handling all kinds of sheet-iron vitreous-enamelled ware. Oil and natural and artificial gas were used for fuel, and some few were electrically heated, using ribbon resistors. The development and improvement to the present-day furnace was in the design details, the U-type idea remaining intact and unaltered. It is shown in Fig. 1.

Combustion Chamber

To correct many of the early faults, a cross-firing principle was adopted, and a combustion-chamber construction, similar to that on successful box-type furnaces was used. A type of hearth plate, the V-bottom, which permitted increased radiation per sq. ft. to hearth area, and was available in the thin-section super-refractory plates, was adopted.

By cross firing the use of small multiple-fuel burners was accomplished, the flame shortened, and each combustion chamber or tunnel was independent of adjacent ones, all of which permitted better and more flexible burner operation. This multiple-burner application, combined with the use of the thin-section high-conductivity hearth plates, permitted a con-

* A Paper read before The Institute of Vitreous Enamellers, Mr. H. Whitaker presiding.

siderable increase in hearth radiation, and a uniform temperature throughout the burning chamber.

In adopting the cross-firing principle, no change in sidewall construction or method of handling flue gases was necessary. The burners were staggered, and each successive one from back to front of the burning chamber was fired from opposite sides, and the gases from each chamber passed up behind the muffle side opposite its burner.

These multiple cross-firing burners also permitted flexibility in the length of burning chamber, since it was only necessary to increase or decrease the number of burners and combustion chambers. Also, by their use, better proportioning of air and fuel was possible, because less fuel was handled per burner and excessive temperature spots eliminated; thus, the refractory punishment was less severe and a longer refractory life was obtained.

Air Seal

One of the most troublesome conditions encountered in the development of the continuous furnace was a tendency for longitudinal drafts, or air currents, within the preheat and cooling zones which affected temperatures within the burning chamber on the shorter furnaces and caused considerable loss of heat at the front on all of them.

An out-rush of hot air in the upper portion of the front opening was accompanied by an inrush of cold air at the bottom of this opening, and to correct this an air seal was installed at the front. It consisted of a small motor-driven blower mounted to one side at the front.

Details of this were explained during the showing of the film which followed this Paper.

Air Curtain

Another improvement utilising air was an interior air curtain. A large-volume motor-driven blower with water-cooled bearings was mounted on the outside, and short manifolds passed through the zone sidewall. In addition, this interior air curtain aided the front air seal, in that it stopped longitudinal air currents in the furnace short of the front seal, since its movement was at right angles or lateral. The combination of this front air seal and interior air curtain was most effective, and the idea of additional interior air curtains as a means of effecting further fuel savings was tried on several installations.

Enclosed Slot

Heat loss by radiation and conduction through the roof slot was apparent, although not serious. On several installations where the unit fuel cost was comparatively high, especially on electric furnaces, the slot and conveyor were tightly enclosed on the sides and top with an insulated housing. This showed a fuel saving, but caused conveyor difficulties, since the chain and trolleys within the enclosure were subjected to quite high temperatures. In addition, in the burning of vitreous enamels, there are chemical reactions taking place during the fusion and fluorine gases are given off.

Unless the burning chamber is freed of these gases, the quality of the finished ware, especially the gloss, is affected. Enclosing the slot prevented any possibility of the burning chamber ventilating itself of these gases, and this trouble was in evidence.

The objections were more important than the fuel savings, and the practice of totally enclosing the slot and chain was discontinued, although it is used on some installations, but the enclosure at the 180-deg. turnover burning chamber is usually omitted to provide this necessary ventilation, and to cool off the roller nest and trolleys.

The Improved U-Type Furnace

The foregoing remarks describe the progressive development from the initial box type to the present-day continuous furnace, which is a well-balanced unit functioning smoothly and continuously without shop congestion. Its exterior is cool, and working conditions near it are satisfactory.

The burner equipment is quiet and positive, requiring no supervision or adjustment regardless of the tool loading or hours of operation. The conveyor runs smoothly, carrying light tools heavily and solidly loaded with ware. By observation from the front, the passage of ware from entrance to exit can be seen, and by observing its operation, the advantages and economies claimed for this furnace are apparent.

Tooling the Furnace

The development and improvement in burning tool design was coincident with the development of the furnace. Since the furnace was used for the burning of table tops, stove parts, hollow-ware, refrigerator parts, signs and other miscellaneous items, the tooling resolved itself into an individual problem for each class of ware to be handled. The basic requirements for all tools, however, regardless of type of ware burned, were the same, and these are:—(1) A metal mechanically strong, capable of withstanding continuous alternate heating and cooling without crystallising or becoming brittle, and with a minimum amount of scaling, having all of these properties at a temperature of 1,600 deg. Fah. (870 deg. C.); (2) a design to permit the loading of a maximum amount of ware, of various sizes, per foot of furnace chain, easy and quick to load and unload, and so to

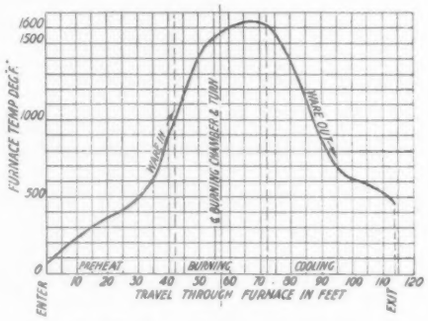

FIG. 2.—HEATING CYCLE FOR THE TYPE OF FURNACE SHOWN IN FIG. 1.

support the ware as to reduce warpage of ware and tools to a minimum; and (3) a weight as light as possible so as to provide a higher ratio of ware per pound of tool, since the fuel cost for heating tools is practically the same as for the ware.

The most modern tools to-day are predominantly castings, although some are fabricated from rolled sections. On others the main frame or supporting bars are castings, and the hooks for hanging the ware of drawn wire. There are many compositions in the nickel-chromium-alloy field which are suited for tools, and a typical analysis widely used is as follows:—

	Composition.	
	Cast bars.	Rolled bars.
C	0·4 max.	0·4 max.
Si	1½–2½	1·0 max.
Mn	2½–3½	2½–3½
Cr	18–22	18–22
Ni	30–34	30–34
Iron	Balance	Balance

Conclusion

This improved U-type continuous furnace has been successful in accomplishing the results needed by the industry, in that it has eliminated the basic faults of the box-type furnace and has also overcome the disadvantages of other types of continuous furnaces, and these advantages have, over the past ten years, been definitely proven.

This improvement, combined with a reduction in the number of handlings, less warpage, a more uniform burning temperature (Fig. 2), an improved thermal efficiency, and a decrease in the direct and auxiliary lay-out required, have all contributed in enabling the industry to produce a better quality of ware at considerably less cost than was possible with the box-type furnace.

It has overcome the objection of other types of continuous furnaces. It is adaptable to any shop lay-out without excessive use of floor space, and has eliminated the necessity of double supervision. The faster conveyor travel has permitted an increase in capacity, and the difficult problem of cleaning out the furnace and quick repairs has been solved. Maintenance expense, a considerable item on all previous continuous furnaces, has been fixed as a secondary consideration since several of these U-type furnaces have been under constant heat for more than two years with no expense other than the labour of minor adjustments.

The closed end, together with the air seal and curtain, have made uniform temperatures possible throughout the burning chamber. As the engineering profession progresses it is expected more will be accomplished. There will be an increase in the knowledge of the principles of combustion and furnace design, better materials and better methods of burning fuel, all of which will be adapted to the continuous furnace and improve it still further.

At the conclusion of the lecture a very interesting cinematograph film was exhibited, showing the details and working of the continuous furnace.

DISCUSSION

The CHAIRMAN (Mr. H. Whitaker) observed that the present-day tendency was in the direction of mechanisation, as was noticeable in the installation of mechanical spray booths and sand blasts, as well as of mechanical furnaces.

MR. W. H. WHITTLE mentioned that in conversation with the author of the Paper he had referred to the firing of different grip coats and so forth. It was usually understood in the sheet-metal practice of this country that grip casts, and even double-sided work, should be fired on the flat, whereas the cinematographic reproduction showed them to be suspended. The reason which had been given to him for this practice was that the plates were gradually dried on going to the furnace; that they did not go into intense heat right away. In the case of ordinary muffles, as soon as the muffle was opened, the article was plunged in. If the temperature was too high, the iron would tend to buckle until it received the support of the grip coat. Mr. Marshall had explained that, owing to the article going in slowly, it was heated up gradually so that the enamel adhered to it to a certain extent before it entered the fusing chamber proper.

Vote of Thanks

MR. J. W. WILSON, in proposing that a hearty vote of thanks be accorded to the lecturer, said that he had been most impressed with the enormous output of which the furnaces described appeared to be capable. Those furnaces, however, were of such a magnitude that he rather doubted whether the firms at present engaged in the vitreous-enamelling industry in this country would care to install them without giving a very great deal of careful thought to the proposition. When one spoke of expanding, say, £12,000 on a furnace the question of finance began to loom up rather largely. Speaking as an engineer, he always liked to have a furnace in reserve, to provide against what the lecturer had referred to as a "jam"; but at such a price this would hardly appear to be practicable. He was favourably impressed with the ease with which the American operatives dealt with the work. It would seem to be a logical conclusion that the

(*Concluded on page* 351.)

Opacifiers Used in the Vitreous Enamel Industry*

By W. ASTLES (Director of the Union Oxide and Chemical Company, Limited)

Opaqueness is that quality which is given to enamels by certain more or less well-known chemicals and oxides. One of the physical properties on which the practical value of an opacifier depends is the degree to which it reflects the light which falls upon it, and this is largely dependent upon the extent to which the light is bent out of its course or refracted in passing through it. Usually the refractive power of a substance is intimately connected with its density and the refractive index of opacifiers is approximately proportional to their density. Therefore, a coat of enamel would be fully opaque if all the light which was thrown down was reflected back but it is not possible as some of the rays of light are absorbed.

Various raw materials contribute to opacity in the batch and to the index of refraction. For example, tin oxide has 2.04 and zirconium oxide 2.23 index and it is due to the variability or differences in the index figure that opacity develops; at least this is the view of many theorists.

An examination of possible compounds which occur or are commercially available of sufficient purity to render them suitable for white pigments limits one to such materials as the oxides of antimony, zinc, tin, titanium, and zirconium, and zirconium silicate and sodium zirconium silicate and possibilities of thorium and cerium oxides and silicates if the two latter products can be produced at sufficiently low cost. At the very low refractive indices is found the fluorides or sodium, calcium, aluminium, etc.

Common Opacifiers

The most common opacifiers used are tin oxide as a mill addition, zirconium oxide and silicate as mill and melt additions, and antimony oxide as a melt addition, whilst lower down the scale in degree of giving opacity are chemicals and pigments or oxides.

Arsenic is gradually being eliminated because of its poisonous nature, as are zinc and titanium oxides due to their high solubilities in the glass. Antimony oxide is found very satisfactory in certain applications and is extensively used as a melt opacifier. Tin oxide is an excellent opacifier and until recent years held the field as the only satisfactory mill addition opacifier. It is generally more expensive than other mill addition oxides excepting perhaps cerium and thorium compounds which are relatively little known as ingredients for enamels and glazes.

Such materials of low indices as fluorides have some value as opacifiers, but in this case the difference of refractive index ot the glass and the fluoride is much less than that obtained with a glass and a material of high refractive index such as added opacifiers in the true sense. Experience has shown this to be the case as it has been found necessary to supply additional opacifiers in order to produce enough opacity to turn back sufficient light in a thin coating of glass. The following fluoride products are combined fluxes and opacifiers which play a minor or major part in opacity: Sodium fluoride, sodium silico fluoride, cryolite (both natural and synthetic) and fluorspar.

With varying amounts of quartz, felspar and borax no effect has been observed on opacity, yet any variation of fluorspar, antimony oxide, cryolite, etc., showed that such products definitely contributed to crystalline compounds or opacity in the enamel. Fluorspar is present in enamels as calcium fluoride, antimony oxide as the pentoxide, and cryolite most probably as sodium aluminium fluoride.

Zirconium oxide reacts with the glass, forming small globules of ZrO_2 glass of high refractive index. These globules are not too soluble in the enamel and basing on this assertion are retained as such thus giving the required opacity.

For obtaining opacity, heavy coats of enamel are often resorted to in order to achieve the desired strength of colour, but it has many disadvantages, as an enamel which is thickly coated is more costly, will chip off more readily, and not stand the same amount of handling as a thin but dense enamel. Therefore, technically opacity must be secured by way of the formulation, plus the correct opacifier at the mill.

Fluorides

Fluorides cannot be successfully used solely as an opacifier, but they represent an essential "cog in the wheel" whether it be in the form of natural calcium fluoride (CaF_2), *i.e.*, fluorspar sodium alumina fluoride, *i.e.*, cryolite (either natural or synthetic) which is, of course, a double fluoride of sodium and alumina (Na_3AlF_6), or as sodium silico fluoride (Na_2SiF_6). The fluoride compounds may assist apart from opacity in reducing the fusion point of the frit. Taking cryolite as a melt addition the best range to add is generally between 5 and 12 per cent. The amount of cryolite used is governed by the work in hand.

Titanium Oxide

Titanium was discovered by Gregor in 1791. Titanium is the ninth most prevalent element found in nature and occurs as ferrous titanate in the mineral ilmenite and as the oxide in the minerals rutile and brookite. Until recently titanum was used in ceramics only in the form of rutile and then as a stain in pottery bodies and glazes. Light ivory to dark tan colours are obtained, depending on the amount used.

It is only since 1929 that TiO_2 has been available at a price permitting its general commercial use in ceramics. The physical properties of TiO_2 are:—Specific gravity, about 3.95; index of refraction, 2.50 to 2.90; colour, white, and melting point, 870 to 980 deg. C.

Titanium oxide is not a true opacifier in the vitreous-enamelling sense, yet as a paint pigment it is the most opaque white pigment known. For this reason, extensive references to titanium appeared in early patent literature as a mill addition, but modern research has proved this to be unfounded.

The functions of titanium oxide in enamels lie in its specific properties when used in the raw batch, while in some cases, as noted by Landrum and Frost, it will cause opacity by crystallisation. Titanium oxide, when used in the formation of enamels, containing the usual enamel batch ingredients, tends to produce "off-colour" enamels. It is too powerful a flux and dissolves too readily in enamels to be used successfully at the mill as an opacifier.

Tin Oxide

This is as yet foremost in the field of opacifiers and has been used for many years as a mill-addition opacifier. Its index of refraction is 2.04 and the density 6.95. Generally speaking, this oxide is not dissolved in fusing and remains as a crystalline oxide if properly fired. The impurities occasionally are tin metal (Sn) and stannous oxide (SnO) apart from slight traces of carbon or impurities present due to its manufacturing process.

It has been recognised as one of the most reliable opacifiers used, but recently other oxides of non-ferrous metals are forging ahead on considerations of economy. Tin oxides vary in their opacifying properties and the safest test is a bulk trial, preferably in a cream or buff, when its opacity on firing the enamel can be observed. As much depends on its physical properties as on its chemical purity.

Great progress has been made in improving the qualities of tin oxide, yet it has one serious drawback in its use as a mill-addition opacifier for wet-process cast-iron enamels which are now generally applied direct to the metal. It has been established that stannic oxide, if used in enamels applied direct to cast iron, can be, and sometimes is, partly reduced to black stannous oxide resulting in black specks on the enamel surface.

Danielson and Frehafer made tests as to reflection or whiteness and established a reading of 70 per cent. (taking magnesia oxide as 100 per cent., presumably on a colorimeter of Bausch & Lomb type) using 7 per cent. tin oxide at the mill, which is quite a good reflection, and tests made in America show that on sheet-steel enamels increasing amounts up to 7 per cent. definitely affected the opacity dependent on the composition of the enamels studied. This can be taken almost as an economic optimum figure, as beyond this point the intensity of light reflection was not increased in proportion.

Andrews, as the result of investigations made in the Ceramic Department of the University of Illinois, confirmed that the addition of tin oxide in amounts exceeding 10 per cent. gave little or nothing to the opacity, but increased the brittleness.

With regard to the demand, hollow-ware manufacturers have continued to keep quite consistently to tin oxide, and represent by far the largest users, but where the adjustment of the frits has been undertaken, other opacifiers are being successfully used.

Generally speaking, it produces a warm white, but for refrigerators, etc., the preference to-day is for a blue or cold white, and to achieve this sometimes tin oxide is used in equal parts with zirconium oxide, or in some instances is being entirely replaced by zirconium oxide, with a reduction in enamelling costs.

Zirconium Oxide and Silicates

Zirconium oxide has been used successfully as an opacifying agent in enamels for some time.

* Paper read before The Institute of Vitreous Enamellers, Mr. B. B. Kent presiding.

Development of the Continuous Vitreous Enamelling Furnace

(*Concluded from page* 350.)

handling of the work, both before and after it had been fired, should be done mechanically. He was at a loss to understand why more attention had not been paid to mechanical handling. Obviously the articles had a high temperature as they left the furnace, and judging by the appearance of the workers they seemed to become somewhat fatigued.

Mr. W. H. Whittle seconded the vote of thanks. He remarked that the engineer always wanted mechanisation and still more mechanisation. The comment might be made that there were at present a few million unemployed people in the U.S.A., and probably, if Mr. Wilson was over there, there would be a few more. What had been clearly shown, however, by the cinematograph film was that methods of mass production could be applied to vitreous enamelling. It would, of course, be noted that such methods could not be applied to jobbing foundries, so that with the exception of, say, a few large stove makers in this country he could not see that there would be any demand for such furnaces.

Its effect on the physical properties of the enamel has only been recently appreciated. Zirconium oxide has a specific gravity of 5.75, melting point of about 2,900 deg. C., and an index of refraction of 2.23.

The author has recently been privileged to observe in various American and Canadian plants the remarkable progress that is being made in incorporating zirconium products in both dry- and wet-process cast iron and in sheet-steel enamels. In dry-process bath enamels (lead and antimony free) using sodium-zirconium silicate, opacity as high as 94 per cent. and as low as 80 per cent. was possible, dependent on the amount used in the frit (no mill addition opacifier being added). These enamels show good refractory properties, high resistance to stains, intense gloss, and definitely represent a new advance in dry-process enamelling technique in U.S.A., although some good work has been done in Germany on this type of enamel formulation.

Zirconium oxide has been used quite successfully in most cases, and only in a very few cases unsuccessfully. Its high refractive index makes it a very good opacifier. The explanation of any slight failure as an opacifier probably lies in the fact that in certain types of compositions it is to a certain extent slightly soluble, and a proportion goes into solution. This can be adjusted by an alteration to the frit formulæ.

Zirconium metal has a very great affinity for oxygen and only one oxide of this metal is known. This oxide is stable at all temperatures encountered even in ceramic glazing. These points are important in the light of new developments, such as enamels used direct on cast iron—no ground coat being used.

Regarding the early manufacture, many processes were tried with various results, and of these results a few were found to be not too satisfactory at first. Several of these products, however, are now in use as opacifying agents, primarily as a mill addition to enamel frits. The major part of the zirconium oxide content of the opaque frit is introduced as a zirconium silicate or a sodium zirconium silicate in the melt. When in the proper combination, these products will produce excellent opacity. There is still some doubt as to whether the opacity thus produced is due to zirconium oxide crystals or crystals of some other zirconium compound.

A. E. Andrews and J. P. Breen, in their Paper* "X-Ray Investigation of the Opacifying Compounds Present in Sheet-iron Cover Enamels," have stated that the X-Ray did not indicate that zirconium oxide crystals were present as such. At any rate, it is known that certain constituents are either necessary or very beneficial in producing zirconium opacity. One of these materials is alumina. This material is of primary importance, as a silicate low in alumina (Al_2O_3) will dissolve a large amount of melt addition of ZrO_2 with little opacifying effect. By using zinc oxide it has been found that the opacity of ZrO_2 is improved.

However, certain other compositions being devoid of ZnO have very dense opacity. Calcium and barium oxide in proper proportions act in a similar way as zinc oxide in improving the opacity. In order to show that the opacity thus produced is dependent on the ZrO_2 and not a ZnO-Al_2O_3 or CaO-BaO-Al_2O_3 compounds, a frit was prepared introducing the ZrO_2 as sodium-zirconium silicate. If one-half of the ZrO_2 content is replaced by Al_2O_3 in the form of felspar, the opacity is only about 25 per cent. of the original. When all of the ZrO_2 content is replaced, there is only a very faint milkiness in the glass.

There is very little that can be said as a general rule which will apply to the whole range of temperatures at which various frits are smelted. For instance, a certain composition under review is very opaque at enamelling temperatures, but when heated to temperatures about 1,020 deg. C. it begins to lose opacity by becoming devitrified and the ZrO_2 entering into solution.

In this research it has been found to be more advantageous to calculate compositions to the basis of percentage of the oxide content rather than to "norms" or "molecular formulæ," as this method was found to be more adaptable as to prediction of the results obtained.

The alkalis sodium and potassium oxides are fluxes, but are used to some extent to control the expansion of the glass. They do not seem to exert any appreciable effect on the opacity when used in amounts up to even 15 per cent. in enamels.

Zinc Oxide

Although dense opacity has been produced with zinc-free glasses, it seems to be better to use this element where it is not objectionable, as it is somewhat easier to control in regard to opacity *versus* texture. It is easier to obtain a densely opaque yet glossy surface with the use of zinc oxide in conjunction with zirconium. Although zinc-free enamels of dense opacity tend to be more of a matt in texture, good gloss glazes have been obtained without the use of zinc oxide, but are generally more sensitive toward cooling conditions.

Calcium Oxide

Calcium oxide is a constituent contributing somewhat towards the formation of zirconium opacity, but is desirable primarily as a flux and as a control of texture; usually 4 to 5 per cent. seems desirable.

Barium Oxide

Barium oxide is an active flux contributing towards zirconium opacity. If too great an amount is used, it will precipitate in rather large crystals, producing a texture varying from a matt to one which appears immature even though it is definitely known that the frit was once melted to a good glass.

Boric Oxide

Boric oxide is slightly deleterious to the opacity, but this property is offset by its effectiveness as a flux and as an ingredient tending to produce a bright, glossy enamel. Too much B_2O_3 promotes "crawling."

Alumina

Al_2O_3 has been found most advantageous in connection with zirconium.

Silicon

Silica serves its usual function in an enamel glass, and is varied to control hardness (maturing temperature), texture, as well as expansion. The control of expansion, however, has been found best regulated by other means. It should be kept as low as possible for zirconium opacity.

It is noteworthy that pure white glazes were made with zirconium opacity in contact with chrome vapours under the same conditions that coloured tin-oxide glazes various tints of pink. The author has never been able to produce a pink with zirconium opaque glazes by the use of chromium without the addition of tin oxide, using clay bodies.

Lai investigated the use of zirconium products as far back as 1927, and an article which appeared in the "Journal" of the American Ceramic Society in March of that year pointed out that on sheet-steel cooking ware zirconium oxide and sodium antimoniate gave excellent results against tin oxide (antimony in any form is not now used in this country in enamels on cooking utensils).

Lai further pointed out that these, so to speak, replacing opacifiers also improved some of the physical and chemical properties; zirconium oxide particularly contributed to resistance to thermal shock. These features were the more noticeable in high felspar and low quartz and fluoride enamels. America has led the way in the last fifteen years in research on the purification of these, as, although the properties were then known, its use did not become extensive, due to the difficulty of obtaining it in a reasonably pure form free from iron, and this impurity has since been eliminated.

Zirconium oxide is added at the mill, and gives a blue or cold white enamel, whereas tin oxide gives a warm white result. It is admitted that in certain very limited cases on sheet steel a direct replacement part for part for tin oxide is only possible when the frit formulæ has been slightly modified, but American producers are now manufacturing a new and further improved zirconium product, which has been tested in thirty standard frits on sheet steel in fifty different enamelling plants in U.S.A., with results they claim quite equal, and in some cases superior, to tin oxide, replacing part for part on sheet steel with an average opacimeter readings on these frits of 77.

Direct White Ground Coats for Sheet Iron

Although no commercial result has as yet been achieved, tests show that the irreducible characteristics of ZrO_2 to any other oxide make it an ideal opacifier for this work, as it is not reduced by contact with iron and retains a white appearance.

Mill Additions.—In order to produce a dense opacity, the usual mill additions of zirconium oxide are about 6 to 8 per cent. for wet-process sheet-steel and cast-iron work, and amounts of 2 to 3 per cent. have been successfully used on dry-dusting bath enamels or have been completely eliminated where sodium zirconium silicate from 15 to 25 per cent. has been used in the melt formulation. Commercially, pure qualities of zirconium silicate and sodium zirconium silicate are now available and these are being successfully used as follow:—

Zirconium Silicate.—For refractory and opacifying of clay bodies and for dry-dusting cast-iron bath enamels.

Sodium Zirconium Silicate.—For opacifying, as a flux and to give refractory properties to the enamel for wet- and dry-process enamels; already used in U.S.A., Canada, Holland, and in this country for hollow-ware—giving a dense cold-white result under certain formulations with excellent lustre and white colour and also particularly suitable for coloured enamels. *In dry-dusting* leadless and antimony-free bath enamels, zirconium products give super whiteness and brilliance with a satisfactory alkali resistance which is important for bath enamels.

The determination of crushing, tensile and transverse strength and also modulus of rigidity of quite a number of different type enamels have been made, and showed that in all cases the enamels were greatly improved in these physical characteristics where zirconium compounds have been used.

Present Position of Zirconium Compounds

To summarise the position the recognised properties which zirconium opacifiers impart when milled with proper enamels are:—Cold white or warm white colour as desired; stability of colour in colour oxide mill additions, partly because of zirconium's original whiteness and partly because of zirconium's inactivity with colour oxides and base metals; the irreducibility of zirconium oxide, thus assisting in the control of high-quality porcelain finishes; stability of cost; tendency to improve the set of the enamel, and desirability in acid-resisting enamels.

The place of zirconium opacifiers in wet-process enamels is established, not only because of its closer colour-match, but also as before mentioned, because of colour stabilisation and the increased strength given to the enamel.

In addition to the above, the general conclusions drawn from the preceding remarks are as follow:—(1) Zirconium oxide in proper combination imparts a high degree of opacity to an enamel; (2) the amount of solution of zirconium

* "J.A.C.S.," Vol. 16, No. 7, p. 325.

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oxide in enamels is dependent to a large extent on the kind and amount of other constituents, such as aluminium oxide, zinc oxide, calcium oxide, barium oxide, etc., and (3) any zirconium oxide which may go into solution in the enamel imparts properties to it which are of distinct advantage, as the tensile and compressive strength are increased.

Antimony Oxide and Its Salts

The oxide has an index of refraction of 2.60, and represents the largest consumption of all white opacifiers in the melted batch in spite of its disuse in hollow-ware in this and certain European countries, due to its alleged toxic characteristics on which there seems to be very divergent views, and it is known that the oxide is innocuous under properly-prepared conditions, that is, when incorporated in the batch of acid-resisting enamels, as the usual vegetable acids cannot attack the enamel.

One British works, however, has been smelting antimony for some fifty years, and for the last thirteen years has been making some thousands of tons as a pigment for paints, etc., and vitreous enamels, and has not had the slightest trouble with poisoning amongst its workmen. Antimony, generally speaking, is used in wet- and dry-process work frit formulation at the melt, either as the oxide or as soda antimoniate. The use of the oxide in the frit formulæ varies according to the opacity required, but, if used in excess, makes the enamel viscous in pouring from the melter.

Prepared sodium antimoniate is used more in America and Germany than any other country, and its higher price than the oxide restricts its use, bearing in mind that a greater percentage must be used to achieve equal opacity. Frits containing sodium antimoniate should not be over-smelted or a poor colour will develop.

Antimony oxide is still extensively used in bath-enamel formulations by most British manufacturers (with one or two exceptions), and research is being seriously undertaken in certain directions to eliminate antimony compounds from dry dusting bath enamels due to trouble experienced in variability of enamel-bath colours, instability at different firing temperatures, and to reduction of the oxide when in direct contact with iron.

When using antimony oxide, it is important that the firing conditions in melting or oxidising be closely controlled. Antimony oxide imparts a certain hardness to the enamel, and it has been proved that barium compounds affect the gloss when antimony is used, and these barium compounds should be replaced with calcium compounds (fluorspar and whiting or calcium carbonate).

In dry dusting bath enamels good opacity is obtained by using the standard British antimony oxides, the amounts used in the raw batch varying from 5 to 6 per cent. in a leadless frit, and about 6 per cent. is used in a medium lead-bearing antimony frit containing 6 to 7 per cent. lead oxide.

Sodium antimoniate is used in both dry- and wet-process enamels in the melt in amounts varying from 12 to 18 per cent., but its use is at present, as before mentioned, practically limited to Germany and America for reasons difficult to explain beyond that there are producers in these two countries who have developed their own particular research around this combined opacifier and flux. It is unlikely that a demand will develop in this country in view of the tendency to use other opacifiers free from the word "antimony."

Manufacturers in this country of antimony products have had to live down a certain amount of prejudice due to poor qualities of Chinese antimony oxide formerly shipped and used in enamels, this impure oxide being made direct from the ore by unskilled Chinese labour, and to-day there is on the market an arsenic-free British quality which is generally appreciated with regard to colour and purity and used for vitreous-enamel purposes (sheet and cast iron) except hollow-ware.

Comparison of Relative Capacity

There are differences in results between the left- and right-eye observations due to weakness or fatigue, as the eye is very sensitive to colour changes, including density of white, and naturally the eye can give no actual measurements whereby figures can be compared. Therefore, it is advisable to use the reflectometer or sometimes an opacimeter which polarises the beam of light, so that one can, by varying the crossed nicols, control the beams until their brightness coincides. This ensures accuracy.

In conclusion, there have been many theories as to the cause of opacity, but if enamellers will read reprints from the American Ceramic Society, of September, 1931, and July and August, 1933, covering Papers prepared by Andrews, Clark and Alexander and Andrews and Breen (July, 1933), there will be no doubt in their minds that the determination by X-ray methods of the presence of crystalline compounds causing opacity in enamels is well founded and speaks well for the research conducted by these gentlemen.

DISCUSSION

Density of Tin Oxide

The Chairman (Mr. B. B. Kent), commenting on the author's statement that usually the refractive power of a substance was intimately connected with its specific gravity and that the refractive index of opacifiers was approximately proportional to the their specific gravity, said that there were two types of tin oxide on the market—the medium and the light. Surely the medium type had a higher specific gravity than had the light type; yet very often the light type had greater opacifying quality.

With regard to the statement that zirconium oxide gave a bluish-white colour, whereas tin oxide gave a warm yellowish-white colour, he asked if it were possible to secure a warm yellow colour when using zirconium oxide, for there were frequent demands for this shade. A third question was whether modern frits had zirconium incorporated in them, and, if so, did it make any difference whether one added further tin oxide as a mill addition or added the same opacifier as was contained in the frit?

Tin Oxide Replacing

Mr. Astles replied that in his experience the medium type was the best type of tin oxide to use. A very light one floated far too much, but there was definitely no difference chemically; there was no difference in specific gravity, though one might gain such an impression from a variation of the particle size. With regard to colour, he had had panels made which showed that one could secure a warm white by putting in about 0.001 per cent. of cream oxide at the mill. Incidentally, there was a new product, which he had discussed with Prof. Andrews both here and in America, and which would give a definite replica of the tin oxide result without any adulterant or colouring oxide addition. That was already on the market in Britain. Zirconium was contained in some frits. One should make practical tests, and if one wanted it one could have it put in; a formula could be balanced to include it—preferably sodium zirconium silicate.

The Chairman asked if he advocated that if one were going to use zirconium one should know what was in the frit.

Mr. Astles said he supposed the suppliers of frits would say whether or not a frit contained zirconium, if they were asked, though probably they would not mention it if they were not asked. He saw no reason why it should not be included; it was a matter of balance between zirconium and silica to bring about equilibrium.

Colouring Differences

Mr. Ball, who pointed out that the various qualities of tin oxide gave various degrees of opacity, said that as a quick test an addition of a small percentage of oxide was often made with the mill addition of the tin oxide to the frit; apparently by comparing the resulting colours one obtained a fair estimate of the opacity. It was suggested in the Paper that if one made a mill addition of 5 per cent. of tin oxide in one case and 5 per cent. of zirconium opacifier in another case, using the same mill addition of oxide each time, a darker colour would be obtained where the zirconium mill addition was made; alternatively, one could use a smaller oxide addition. That seemed rather to prove that, according to Mr. Astles' opacity test, the zirconium opacifier did not give an opacity equal to that of the tin oxide.

It was interesting to note, from an inspection of two samples which Mr. Astles had exhibited, that the enamel which appeared to be most opaque was that which contained the larger percentage of colouring oxide.

An Inert Opacifier

Mr. Astles replied that, so far as he could discover, zirconium was the only inert opacifier; it was due to the reactivity of the colour on the tin and the non-reactivity of the colour on the zirconium, that one could use a less percentage of colour when zirconium was added. Twenty-five years of research had been devoted to zirconium in America, and it was pointed out in Prof. Andrews' book that as a result of the inert characteristic of zirconium one could use less, as a rule, although there were one or two exceptional cases. Mr. Astles added that he had given eight illustrations showing that when using zirconium one could use a lower percentage. He agreed that it had given the impression that tin oxide had greater opacity—but it was all a matter of relativity.

Mr. Ball asked if it were suggested that an inert opacifier would tend to give a deeper colour than an opacifier which allowed some combination to take place. Surely, he said, an opacifier which was not inert should give a definitely deeper colour than one which was inert?

Mr. Astles replied that one must accept the tests he had referred to as being genuine; and it had been proved in research in this country that with a zirconium opacifier one could use less. The work in America was well advanced, and he was giving the facts as they were observed.

Eliminating Brittleness

Mr. P. Stone, speaking as one who had been perhaps the largest user of zirconium in this country, said that Mr. Astles' statements concerning the development of colour with zirconium was perfectly true; it developed colour much more than did tin oxide, probably because tin oxide absorbed some of the colour, whereas the zirconium was inert. When using zirconium, one could definitely use a little less colour, as zirconium often gave an added tint in pale-coloured enamels, and also enabled one to avoid much brittleness often experienced in enamelling.

Mr. Astles remarked that progress was continuously being made, and it might be found some day that both zirconium and tin would have to take a back seat in favour of something else. Only by giving due weight to the facts presented from time to time would the trade make progress.

Bath Enamels

Mr. J. T. Gray, commenting on the emphasis which the author had laid upon the elimination of tin oxide from enamel pointed out that tin-free bath dusting enamel had been used for many years in this country.

Mr. Astles agreed. He added that antimony was one of the most used opacifiers in this country. Bath enamels now used here in Great Britain were primarily lead-free antimony enamels, with little or comparatively no tin at the mill.

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MR. GRAY said he thought it should be emphasised perhaps a little more strongly than it had been stated in the Paper that so far as bath enamels were concerned they in this country were probably in advance of the Americans in research, or at any rate, in development.

Temperature and Opacity

MR. G. H. ABBOTT asked whether the temperature at which a molten frit is poured affects its opacity. It would appear, he said, that, as in an ordinary saturated solution of a salt, crystallisation should take place with cooling. Therefore by slightly lowering the temperature of the frit before pouring, not of course to prejudice its grinding, some of the opacifying compounds (zirconia, for example) taken into solution in the glass might be thrown down to give added opacity.

MR. ASTLES intimated that he would prefer to study the question, which was quite well founded, and would give a specific reply later through the Institute.

Cerium and Thorium

MR. THOMAS, referring to a statement in the Paper that the antimony oxide manufacturers had not experienced trouble in regard to antimony poisoning, suggested that that was probably because a higher oxide was being manufactured; probably poisoning was not due to the oxide at all, but to the action of organic acids on the lower oxide, producing poisonous salts. There had been definite instances in which poisoning had been traced to hollow-ware.

Referring to the use of cerium and thorium as opacifiers, he asked whether much research had been carried out in that direction and what results had been obtained. Of course, he added, cerium and thorium were rare earths, and at the moment were not a commercial proposition.

MR. ASTLES replied that the antimony ore had to be treated very carefully; as the result of such treatment, leading to the production of a very pure quality, the toxicity had been overcome. It was perhaps remarkable that he had never heard of such poisoning occurring in China, where the ore was obtained. However, Mr. Thomas was probably right in suggesting that one of the lower oxides was responsible for the toxicity.

Dealing with cerium and thorium, a small production was available on the Continent, but the price at present ruled out its use as an opacifier in this industry—at any rate, in the home market.

Acid Resistance

MR. CHIFFEY asked for information as to the effect upon acid-resisting enamels of adding zirconium silicate in the mill.

MR. ASTLES replied that it was debatable whether zirconium in any form—as zirconium silicate or zirconium oxide—helped acid resistance, but from his own point of view he believed the double salt, *i.e.*, the sodium-zirconium silicate, did help in that respect. As against that, however, America had not very good qualities of acid-resisting frits—it might be that there was not a big demand for them. The producers of enamel ware in Canada were using mainly lead frits. There were quite a number of acid-resisting frits made in America, but until there was a substantial demand, the makers of frits would not work on the problem very much.

MR. BALL, in view of Mr. Astles' reluctance to give a definite opinion as to the effect of zirconium upon acid-resisting enamels, said that Miss Dimbleby, of Sheffield University, had stated definitely that zirconium oxide was of the greatest value in producing acid-resisting glasses; she had placed it very much higher than titanium in that respect.

MR. STONE, commenting on the references to the toxicity of antimony oxide, said it had not been sufficiently emphasised that if it were used in acid-resisting enamel, we should not hear so much about discontinuing its general use in hollow-ware. If acid-resisting enamel were used on all types of enamelled ware, we need not bother about the toxic aspect of antimony oxide.

Fluorides as Opacifiers

MR. ABBOTT, referring to fluorides as opacifiers, said that in practice usually about one-third of the fluorine was lost by volatilisation during the smelting process. Was it possible to secure greater opacity by adding the fluorine compounds at a later stage during the smelting and still retain all the other properties of the frit?

MR. ASTLES said it did not seem to be scientifically possible with the assurance of a fully-mixed and smelted frit.

MR. STONE quoted the old axiom of the enamel maker "well mixed is half made," and urged that if one added a constituent to a half-smelted batch one could not expect it to be properly mixed in the frit. Especially was that the case in materials such as fluorspar, and if such materials were added to a half-melted batch one would experience trouble. His advice would be to add it at the mixing. Discussing the problem of the medium *versus* the light types of tin oxide, he said that probably many would agree that better opacity was secured when using the very light type; but if one tried re-firing it, one often obtained a very sulphury effect. For general purposes it was usually found best to use the medium quality, because it did not come right to the top of the enamel but remained just below the surface. It would give all the opacity that the enamel needed, without producing the sulphury effects.

MR. J. T. GRAY added that during bath dusting, when using a very light tin oxide, the convection currents would cause a much higher percentage of the tin oxide to be blown away into the atmosphere between the sieve and the bath, as compared with using a heavier tin oxide. In other words, a tin oxide can be too light for dusting work.

MR. A. B. KENT said that both types were used at his works, but no difference had been noted.

On the motion of the CHAIRMAN a hearty vote of thanks was accorded Mr. Astles for his Paper.

Publication Received

Aluminium Shopfitting and Display. Published by the British Aluminium Company, Limited, Adelaide House, King William Street, London, E.C.4.

The British Aluminium Company have done a real service to the architectural profession by the publication of this magnificent brochure. The illustrations are of exceptional merit, whilst the letterpress is well written and of appropriate technical balance. The brochure is divided into four sections:—(1) Scope in modern shopfitting; (2) practical application; (3) points on use and fabrication, and (4) uses in shopfitting. It is made very clear that the rôle of external fittings is to catch the eye, so as to induce people to undertake a detailed inspection, whilst the part to be played by internal ones is to be unobtrusive. Castings do not loom so large as the wrought material, and we failed to notice any mention of the small aluminium castings to be covered by chocolate for window displays. This, we understand, is done to prevent any window-soiled sweets to be sold over the counter. Until we had this brochure we were under the impression that most of the semi-human display figures were castings, but now we learn they are but aluminium-faced plywood! We strongly recommend non-ferrous founders to ask for the favour of a copy of this book as it is full of ideas for the extension of business along artistic lines.

The British Cast Iron Research Association

(*Concluded from page* 345.)

iron thereupon came into disrepute. This was obviously either a case for the education of the production side or for research. He recognised that cast iron was still the backbone of the mechanical-engineering profession and no sooner was it ousted by a rival from one use than it cropped up in some unexpected employment elsewhere.

Excellent work had been done in forwarding the development of the balanced blast cupola, and this had improved melting and brought cupola practice to an almost scientific operation. He understood that the Association was now carrying on research into shrinkage troubles in castings, and if useful information in this respect could be obtained it would relieve one of the biggest difficulties in foundry practice.

Speaking officially as representing the Institution of Mechanical Engineers, Col. Davidson said it was with pleasure he noted the establishment of the Foundry School by the Association because the Institution of Mechanical Engineers had co-operated in its formation. The Institution of Mechanical Engineers was responsible for the conduct of National and Higher National Certificates in Mechanical Engineering, which could now be endorsed in foundry work, and the Institution believed that the new School would raise the whole status of teaching of foundry subjects throughout the country. In spite of the growth of other materials, cast iron still remained of extraordinary importance to the mechanical engineer, and it comprised something like two-thirds of the output of engineering products in this country to-day. In the past, design of cast-iron structures, originating as they did when design was empirical, followed traditional lines, but there were signs that the design of castings could be put on a more scientific basis. The improvements in stronger irons and in alloyed irons had been realised most readily by the automobile industry, which made considerable use of centrifugal liners, alloy cast irons, heat-treated irons, and so on. Where special irons were needed for particular purposes it would be necessary for machine shops to sympathise with the founder's point of view, and not to compare the machining properties of these new irons with those of the common materials to which they had so long been accustomed.

MR. P. J. HANNON (M.P. for the Moseley Division of Birmingham until the dissolution of Parliament), who seconded the vote of thanks, said it was gratifying to him to know of the close co-operation and kindly understanding and mutual help which obtained between the Birmingham Education Committee and those responsible for the management of the School which was housed in the Central Technical College under Dr. Anderson, a man who occupied an outstanding position in the scientific life of the City. The work of the School was also very actively supported by the Chairman of the Education Committee in Birmingham, who was an ex-Lord Mayor and had taken an active part for many years in the extension of the educational facilities of the City. He would also like to put on record, said Mr. Hannon, the work of the Chief Education Adviser in Birmingham, who also was closely interested in the work of the Foundry School.

The vote of thanks to the President was cordially given, and the brief acknowledgment by the President brought the proceedings to a close.

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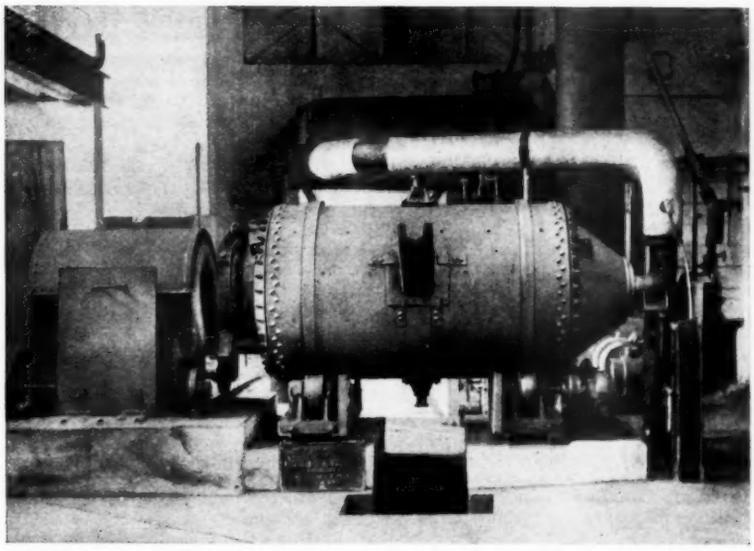

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Opening Meeting at Bradford

MR. NEATH'S PRESIDENTIAL ADDRESS

The first meeting of the new session of the West Riding Branch of the Institute of British Foundrymen was held at the Bradford Technical College recently, and was largely attended. Mr. F. K. Neath, B.Sc., presided.

MR. NEATH, delivering his presidential address, said in the course of his remarks that he proposed to make a few remarks about the foundry industry of the West Riding of Yorkshire and the function of the Institute in relation to it. As he saw it, the foundry industry of this district comprised foundries attached to works engaged in machine-tool, steam and textile engineering, with a number of general jobbing and specialised foundries. The post-war trade depression had made a big difference to the tonnage produced in many of these foundries, but the greatest changes had been caused by the rapid developments in the engineering and allied trades. The change-over from comparatively heavy and slow-moving machinery to light high-speed machinery seemed to have reached every corner of the engineering industry. This, together with the advent of mass production methods, had led to an entirely new set of foundry problems. The engineer now called for castings of intricate design to very close limits of dimensions and of improved metallurgical quality. The desire to save weight often led to casting designs which called for the utmost skill in patternmaking and moulding methods if sound castings were to be obtained.

The New Conditions

The more stringent tests for mechanical strength or pressure tightness demanded a close control of metal mixtures and melting practice if successful results were to be obtained. To his personal knowledge quite a number of local foundries were now successfully making castings which would have been impossible by using the materials and methods of a few years ago. At the same time a good number of the foundries in that district had a long way to go if they were to become as efficient as some of their competitors were and to find the means of meeting the competition of other industries such as welded components, plastic mouldings, etc. They could not stop the development of new methods and new industries. What they must do was to keep in touch with the activities going on in their industry in order to be ready for the developments which were bound to occur.

The Rôle of the Institute

It was in respect of that necessity that their Institute performed its most useful function. He would ask them to throw their minds back to the early days of the Institute's history. Since 1904, when the Institute was founded, there had been a number of developments which had come to general usage almost entirely through presentation and discussion of Papers at branch and general meetings of the Institute. To mention such terms as semi-steel, oil-sand cores, fracture and analysis, was merely summarising the contents of the pages of the volumes of the Institute's proceedings. He ventured to suggest that such titles as sand control, high-quality cast iron, and special bronzes were the modern counterparts of the earlier and now generally adopted developments.

These references might appear to relate to technical rather than practical matters, but he did not wish for a moment to infer that the more practical matters were overlooked or unimportant. Such matters as moulding methods, sound castings, melting practice, and pattern construction always had been, and always would be, the subjects of many useful discussions at their meetings, and had a very general appeal. The motto of the Institute was "Science hand in hand with labour." He thought that in their 31 years of "married" life, the two figures portrayed in the Institute's crest had founded a new generation of foundrymen, to the benefit of the industry generally. The social side of the Institute's work was not less important. The members of the Institute met each other to hear and discuss a lecture or to visit a works. At the same time they met their fellow-foundrymen and "talked shop."

One might wonder why he was preaching to the converted. His reply was that membership of the Institute was a matter of enlightened self-interest, to use a phrase which had recently been made famous at Geneva. He would like every member to ask himself, "What do I get out of the Institute?" and "What do I put into the Institute?" A little consideration would show that these two questions were really one and the same. The true value of the Institute was the value given to it by the individual members. That West Riding Branch was as useful and successful as the members made it. He was not making these remarks with a view to asking them to persuade all their foundry friends to become members of the Institute. Any worth-while increase in the membership, or in the activities of the Branch, could only be obtained if they, as individual members, were satisfied with their own membership.

Root and Branch

His remarks had been confined to Branch activities, because the Institute was really composed of ten main Branches, representing the various industrial areas of the country. The word "Branch" was, in his view, erroneous. He considered that "root" was a more appropriate description. From these roots had grown a strong plant in the form of a national institute which its members could view with pride. The work of the Institute on a national basis was increasing considerably. The recent developments in foundry education were the result of much hard work by the Education Committee. The Technical Committee was gradually building up a centre of collective authoritative opinion which could not fail to be an asset to the foundry industry as a whole. Internationally the Institute's reputation stood high, and perhaps its secretary, who was to be with them that night, would be able to make a few remarks in his capacity as hon. secretary of the International Committee of Foundry Associations. He would ask them to bear in mind during the session that they were now commencing that the usefulness and success, both of the Institute and the individual Branch, would be in degree proportionate to the personal participation of the individual members.

Foreign Foundries

Later a lantern lecture on "First Impressions of Foreign Foundries" was given by Mr. T. Makemson, the secretary of the Institute.

MR. MAKEMSON who, in the course of his address exhibited a great many lantern slides of the interiors of works in America and on the Continent, covered, *inter alia*, the works of Skoda; Ceskomoravaska, Danek Koblen; Vitkovice and other foundries in Czecho-Slovakia; Ford's; Allis Chalmers; Worthington Pump, and General Motors Corporation in America; Schneider & Company; Renault and Citroen, in France; Cockerell in Belgium and Fiat in Italy.

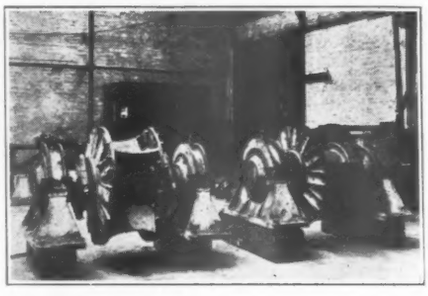
A vote of thanks was accorded to Mr. Makemson on the proposal of MR. CARTER, which MR. FEARNSIDE seconded.

MR. MAKEMSON said it was very good of them to have received him so kindly as they had done, and he was greatly obliged to them for their reception. He had not visited them as much as he would have liked to do, but if they realised the number of Saturday meetings that he had to attend—covering quite 40 out of the 52 in the year—and often involving travel over the Sundays, they would understand what his position was in relation to week-end visits to any particular branch.

Headgear for South African Copper Mines

The illustration reproduced is of the Selkirk headgear manufactured by Sir William Arrol & Company, Limited, for the Mufulira Copper Mines of South Africa. The headgear will wind both skip and cage, which descend to the maximum mine depth of 2,700 ft., at speeds of 1,500 ft. per min. up to 1,600 ft. and thereafter at 2,500 ft. a min.

The skip alone weighs 22,000 lb., and will hold 22,000 lb. of ore. The cage is designed



to accommodate 136 men, whose total weight is computed at 21,000 lb., or alternatively will hold material up to a weight of 24,000 lb. As both skip and cage are operated on the balance weight principle, the headgear, which is mounted on eight 2-row Timken tapered roller bearings of 10 in. by 17.5 in. by 6.5 in. dimensions, will support the possible deadweight of two skips or cages complete with the materials they contain, or a maximum of 90,000 lb.

Relation of Grain Size to Condition of Aluminium-Alloy Propeller Blades

According to the U.S. Bureau of Standard Notes, the periodic inspection of aluminium-alloy aeroplane propeller blades, as practised by some users, consists in anodic etching of the entire blade surface. In this way surface discontinuities are made more prominent and so are more easily detected. The grain structure at the surface of the metal is also revealed. The fact that in many blades the anodically etched surface shows a marked variation in grain size in different parts of the blade has often aroused suspicion concerning blades otherwise satisfactory in their appearance. Recently the Bureau made a survey, by metallographic examinations and tensile strength determinations, of an alloy blade showing marked local differences in grain size.

The smallest grains were found in the round shank and the tip of the blade, whereas extremely large grains were found in the middle part of the blade. In general, the grain size seen on the surface persisted throughout the thickness of the blade. The highest tensile and yield strengths were obtained for the specimens from the shank. Specimens from the flattened portion of the blade did not differ significantly in strength, but the ductility, as measured by elongation and reduction of area of the fractured tensile-test specimens, increased progressively from the shank to the tip, probably in accordance with the increase in amount of deformation in forging the blade to shape. In general, the results did not support any general condemnation of propeller blades on the basis alone of unusual grain-size characteristics.—(Light Metals Research.)

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This Week's News in Brief

Trade Talk

EXTENSIONS TO THE WORKS of Shanks & Company, Limited, Barrhead, have been approved by the Dean of Guild Court.

THE BRITISH TITANIUM COMPANY, LIMITED, is being wound up voluntarily. Mr. James Rochester, 3, New London Street, London, E.C.3, is the liquidator.

THE ORDERS TAKEN at the Motor Show at Olympia, London, are estimated by an official of the Society of Motor Manufacturers to be in the region of £10,000,000.

THE STAVELEY COAL & IRON COMPANY, LIMITED, has secured a contract for the supply of pipes to a waterworks in Colombia. The value of the contract is £7,500.

ANTICIPATING FURTHER EXPANSION in British Automobile production, Messrs. Head, Wrightson & Company, Limited, of Thornaby-on-Tees, have extended their automobile drop-forging plant.

THE CALEDON SHIPBUILDING & ENGINEERING COMPANY, LIMITED, Dundee, have booked orders for two modern-type motor coasters for the General Steam Navigation Company, Limited, London.

THE LONDON MIDLAND AND SCOTTISH RAILWAY, it is announced, will build rolling stock, etc., during 1936 to the extent of about £2¼ million. The work will be carried out mostly at Derby and Wolverton.

A COMPLETE SOUND PICTURE of work at Colville's Steel Mills, Motherwell, one of the largest rolling mills in the world, will be broadcast on November 14. Mr. Keith Murray will give a running commentary on the men at work.

LETTERKENNY (COUNTY DONEGAL) URBAN DISTRICT COUNCIL this week approved of the letting of the former gasworks to Messrs. John Brown, iron-founders, of Londonderry, for the purpose of starting a foundry in the town. A lease was granted for a period of 20 years.

JOHN NORTH (FOUNDERS & ENGINEERS), LIMITED, inform us that they are changing their address on and after November 9 from 396, London Road, Isleworth, Middlesex, to Aintree Road Works, Greenford, Middlesex. Their telephone number will be Perival 5664 (five lines).

MESSRS. HARLAND & WOLFF, LIMITED, have received orders from the Burns & Laird Lines, Limited, for three twin-screw motor vessels. The machinery will consist of Diesel engines of the Harland-B. & W. type. It is expected that the vessels will be built at Belfast.

MESSRS. P. & W. MCLELLAN, LIMITED, Clutha Works, Glasgow, have secured through Crown Agents for the Colonies the order to supply the entire structural iron and steel work for the new Treasury and Post Office building which is being erected at the Port of Spain, Trinidad.

THE FULLWOOD FOUNDRY, Burnbank Road, Hamilton, was granted permission at Hamilton Dean of Guild Court, this week, to erect a new steel building to be used as a patternshop. This is the first step towards the extension and improvement of this already well-equipped foundry.

MESSRS. YARROW & COMPANY, LIMITED, Glasgow, who have secured orders to build two destroyers for the Admiralty 1935 programme, will be one of the busiest firms in the country. They already have two Admiralty vessels in course of construction, and in addition they have a large number of turbines and water-tube boilers for marine and land purposes under construction.

Correspondence

(*Concluded from page* 340.)

rate of 1 in. per hr. occurs irrespective of the quality of the refractory material used? He has not qualified this statement at all, and yet he has been most careful to specify constant conditions for metal mixture, coke ratio, etc. This is a most important point from the foundry manager's point of view of cost, and also for the refractory trade, as refractory materials can be bought at from 20s. to 60s. per ton.

Yours, etc.,

S. S.

Nottingham.
November 1, 1935.

THE WHOLE of the shipbuilding, engineering and ship-repairing works of Messrs. D. & W. Henderson & Company, Limited, Glasgow, have been acquired by National Shipbuilders Security, Limited, for £174,881. It is proposed to maintain the establishments under a care-and-maintenance order for the present, in the hope that better conditions may prevail and permit of reopening. The dockyard and ship-repairing business will be continued.

SPEAKING AT DUNS, Sir Godfrey Collins, Secretary of State for Scotland, said that a company with influential backing had been formed to take over works near Glasgow. These would include facilities for the manufacture of pig-iron, tar and cement, and an electric-generating station. The enterprise to which Sir Godfrey Collins referred is believed to be the Scotia Iron & Chemical Company, which was formed to take over the Langloan Iron & Chemical Company's works at Coatbridge.

THE FEELING OF CONFIDENCE which has been slowly increasing on Clydeside since the end of the summer has been fully justified by recent developments in the shipbuilding and engineering industries, and at the moment there is a general atmosphere of optimism. The yards are still far from maximum capacity, but thousands of men who for a considerable time have been idle are finding employment. October has been the best month on the river for over five years. The new tonnage booked aggregates 80,000 and the output 28,500 tons. In addition to the orders for vessels, large contracts for machinery have been secured by local firms.

Obituary

MR. RICHARD A. PERROTT, the proprietor of the Hive Foundry, Cork, and patentee of the well-known Perrott range, died last week. Mr. Perrott, who was over 80 years of age, at one period employed upwards of 250 men at his works.

COUNCILLOR WILLIAM POOLE, J.P., who has died at his home in Edinburgh at the age of 81, was for over 60 years connected with the firm of A. & J. Main, Limited, Clydesdale Ironworks, Glasgow. He joined the firm in 1871, and on the occasion of his business jubilee in 1922 was entertained and presented with gifts by numerous friends. Mr. Poole was responsible for many improvements in the manufacture of agricultural implements, and he started the first twine binder ever put to work in Scotland. He relinquished active work in 1925.

Contracts Open

Tehran, November 25.—Metal-framed roofing of platforms, turntables, and electric-light standards, for the Kampsax Consortium. The Department of Overseas Trade. (Reference T.Y. 5,407.)

Matlock, November 12.—330 yds. of 4-in. dia. cast-iron water pipes, with valves, hydrants, etc., for the Urban District Council. Mr. J. Turner, surveyor, Town Hall. (Fee £2 2s., returnable.)

Billericay, November 25.—14½ miles of sewers, consisting of 24-in., 18-in., 15-in., 12-in., 9-in. and 6-in. dia. cast-iron, for the Urban District Council. Messrs. Willcox Raikes & Marshall, 33, Great Charles Street, Birmingham. (Fee £5 5s., returnable.)

The Winget Foundry

In our article on the mechanised foundry of Winget, Limited, of Rochester, we stated that the plant was built by Winget to the designs of Foundry Equipment, Limited, of Linslade Works, Leighton Buzzard. We were misinformed to the extent that the cardinal features of the plant were both supplied and erected by the latter concern, whilst designs were also supplied by them for such items as hoppers, elevators, steelwork, and conveyor belts. As this might give the impression that Foundry Equipment, Limited, were prepared to permit clients to manufacture to their designs, we hasten to correct this notion, and regret that our wording was such that this interpretation could be given.

Personal

LORD SEMPILL and SIR GEORGE THURSTON have been appointed to the board of Messrs. Robey & Company, Limited, Lincoln.

MR. VINCENT JOBSON, chairman and managing director of Qualcast, Limited, Derby, is at present in a London nursing home. He underwent an operation for appendicitis, and is making favourable progress.

MR. HARRY RUSSELL, the eldest son of Mr. Frank S. Russell, chairman and managing director of General Refractories, Limited, has been appointed to represent that company in the Eastern Counties. Mr. Harry Russell has just returned after three years' service in Southern Rhodesia in the British South African Mounted Police. He is well equipped for the sale of refractory materials, having served a period of practical work in a number of allied industries.

MR. T. WHITTLE, formerly cashier and secretary to Messrs. Crumblehulme & Sons, Derby Iron Works, Bolton, Lancashire, where he spent 29 years, has celebrated with Mrs. Whittle their golden wedding.

MR. WILLIAM ROLAND, who has been manager of the Cyclops Foundry, Glasgow, which was recently abandoned by Messrs. Workman, Clark & Company, Limited, has been appointed assistant production manager at Messrs. Harland & Wolff, Limited, Clyde Foundry, Glasgow.

Forthcoming Events

NOVEMBER 8.

Manchester Association of Engineers:—"The Application of Ball and Roller Bearings." Paper by F. O. Hickling, A.M.I.A.E., at the Engineers' Club, Albert Square, Manchester, at 7.15 p.m.

Institute of British Foundrymen

NOVEMBER 9.

Scottish Branch:—"The Balanced-Blast Cupola." Paper by W. Y. Buchanan, at the Royal Technical College, George Street, Glasgow, at 4 p.m.

West Riding of Yorkshire Branch:—Visit to David Brown & Sons, Limited, Huddersfield.

NOVEMBER 11.

Falkirk Section:—Three short Papers at the Temperance Café, Lint Riggs, Falkirk, at 7 p.m.

NOVEMBER 12.

Burnley Section:—"Castings Viewed from the Machine Shop re Machinability." Paper by J. Jackson, at the Municipal College, Ormerod Road, Burnley, at 7.15 p.m.

NOVEMBER 13.

London Branch:—"Welfare Work in Relation to Foundries." Paper by R. R. Hyde at the Charing Cross Hotel, London, W.C.2., at 8 p.m.

NOVEMBER 15.

Middlesbrough Branch:—Ten-minute Papers at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

NOVEMBER 16.

Wales and Monmouth Branch:—"Patternmaking—The Craftsman and his Craft." Paper by H. Stead at the Technical College, Newport, Mon, at 6.30 p.m.

NOVEMBER 22.

Lancashire Branch (Junior Section):—"Practical Foundry Experiences." Paper by J. Sherwood at the College of Technology, Sackville Street, Manchester, at 7.30 p.m.

NOVEMBER 23.

Newcastle-upon-Tyne and District Branch:—"The Properties of Foundry Coke." Paper by W. E. Mordecai. Joint meeting with the Coke Oven Managers' Association at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

Scottish Branch:—"Locomotive Castings." Paper by H. Lowe at the Heriot-Watt College, Chambers Street, Edinburgh, at 4 p.m.

The Institute of Vitreous Enamellers

NOVEMBER 7.

Manchester:—"Notes on Furnaces for the Vitreous Enamelling Industry." Paper by Th. Teisen, C.E., at Y.M.C.A., Peter Street, Manchester, at 7.30 p.m.

NOVEMBER 14.

Birmingham:—"Settling and Anti-settling Properties of Clays." Paper by F. H. Clews, M.Sc., A.I.C., at the Chamber of Commerce, New Street, Birmingham, at 7.30 p.m.

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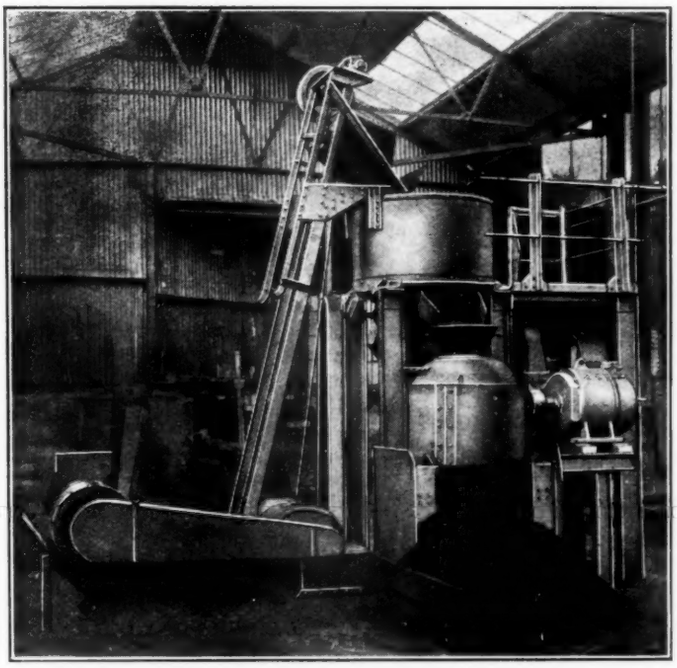

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Raw Material Markets

Producers in most sections of the iron and steel industry have very well filled order books and they are ensured of a high rate of output over several months. Pig-iron, steel semis and constructional material are all in heavy demand and the numerous shipbuilding orders that have been placed recently will increase further the demands made on the steel makers. Forward buying has been more noticeable in view of the increased costs of raw materials, which consumers predicted might result in advanced prices. Last week the Central Pig-iron Producers' Association increased prices by 5s. per ton for Northamptonshire iron and 4s. for Derbyshire iron. Quotations for common finished iron also have been advanced.

Pig-Iron

MIDDLESBROUGH.—Inquiries for material in this area have not slackened in spite of the approach of the General Election. At the time of writing, prices are unaltered, though in the Midlands higher rates now rule. Consumers are in the market for contracts extending over long periods. Prompt sales are difficult to arrange. It is of interest to note that production is now at the highest figure for the year and a very large proportion is going into direct use in the steel furnaces. Both local and Scottish foundrymen are taking up large tonnages and there is very little of the output left for other home or export buyers. The fixed minimum quotations for No. 3 Cleveland G.M.B. delivered to home consumers are 67s. 6d. in the Middlesbrough area, 69s. 6d. on the North-East Coast, 67s. 3d. in the Falkirk zone, and 70s. 3d. on Clydeside.

Producers of hematite in this district are finding difficulty in keeping pace with the heavy demand for iron. Forward buying is heavy and stocks have been considerably reduced. No. 1 East Coast hematite is as follows:—Delivered Middlesbrough, 71s. per ton; delivered Tyneside, 72s.; delivered North-East Coast, 73s. 6d.; delivered Scotland, 74s.; delivered Sheffield, 78s. 6d.; delivered Birmingham, 84s. 6d. per ton.

LANCASHIRE.—Consumption of foundry iron has been well maintained notwithstanding any seasonal relaxation at light castings establishments. There have been some welcome indications of a recovery from Lancashire engineering industries. A steady call for pig-iron has been made by machine-tool makers, as also has been the case with the heavy electrical engineering, general engineering branches and the jobbing foundries. Prices have been increased. Staffordshire, Derbyshire and Lancashire brands of No. 3 foundry iron, equal to Derbyshire, being now quoted for delivery to users in the Lancashire price zone on the basis of 78s. per ton, Northamptonshire at 77s. 6d., Derbyshire forge at 74s., and Scottish No. 3 at around 81s. 6d. There is a steady demand for hematite, with West Coast brands on offer at 81s. per ton for delivery equal to Manchester and East Coast material at from 80s. 6d. to 81s.

MIDLANDS.—Foundry pig-iron is being taken up in large quantities by light-castings makers, and this market is likely to expand. Forward buying has been transacted, in some cases, up to September of 1936, but the furnaces will not venture further than this date. Prices have been increased by 4s. to 5s. per ton. The minimum association rates delivered to Birmingham and Black Country stations are now 72s. 6d. for Northants No. 3 and 75s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, less a small rebate to large users. These prices were fixed at a meeting of the producers held last week. Forge pig-iron remains at 5s. below No. 3 foundry. As a result of scrap and coke becoming dearer, the quotations for special irons for the general engineering trades are showing a tendency to harden. Low-phosphorus iron is quoted at 85s. to 90s. per ton, medium phosphorus at 73s. to 82s. 6d., Scottish at 85s., and refined cylinder iron at £5 7s. 6d. to £7 10s., according to quality. With regard to hematite pig-iron, prices are very firm, and forward buying contracts have been arranged for delivery from March to June of next year. The present controlled rates delivered Midland stations are 84s. 6d. for West Coast mixed numbers, 83s. 6d. for East Coast No. 3, and 83s. for Welsh mixed numbers; 1s. 6d. per ton extra is charged for delivery into works in 10-ton lots.

SCOTLAND.—There is a rather firmer tone in the pig-iron market in this area, but, as yet, the official minimum of 70s. for No. 3 foundry, f.o.t. furnaces, is unchanged, with 2s. 6d. extra for No. 1. Export trade has further increased this week. Official quotations for No. 3 Cleveland are unchanged at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow. Other English foundry iron is at 1s. 3d. per ton less than these figures. Recent shipbuilding orders have ensured greater activity for steel-makers for months to come and they are in the market for both hematite and basic. Official quotations for steel-making irons are as follow:—Mixed numbers Scottish hematite, 73s. 6d.; mixed numbers West Coast hematite, 74s.; mixed numbers East Coast hematite, 74s.; basic, Indian and British, 70s., less 5s. rebate, all delivered steelworks here.

Coke

Prices of foundry coke remain unchanged and the market is very firm. In many instances consumers are endeavouring to accumulate stocks in order to protect themselves against possible labour troubles. For delivery at Birmingham and Black Country stations best Durham coke is quoted at 36s. 6d. to 40s., and Welsh at 32s. 6d. up to 43s. 6d. per ton.

Steel

There has been no decline in the activity which has characterised the steel market for several weeks, says the official report of the London Iron and Steel Exchange. The demand for semi-finished steel is a feature of the position. In many instances the producing works have retired from the market, as they have sold their output as far forward as they care to commit themselves. Consumers, on the other hand, are pressing to obtain deliveries against their contracts, and appear willing to cover themselves as far ahead as the makers will accept business. In the finished-steel department there are few traces of the irregularity which characterised the position a short while ago. Practically all the works have secured a large tonnage of orders and are operating at a high rate. Lately there has been an expansion in export business, which has accentuated the rather tight conditions ruling in some sections of the market.

Scrap

The price of heavy melting steel scrap on the Cleveland market has not been raised, but buyers are finding it difficult to get good tonnages at 52s. 6d. per ton. Machinery cast-iron scrap is scarce and up to 56s. 6d. has been paid for supplies, while for foundry cast-iron scrap 52s. 6d. is still quoted. There is an increased call on clean light cast iron and 44s. has been paid. The demand for scrap in the Midland district is good and prices are showing an inclination to rise. Sales are mostly in small parcels for prompt delivery. Quotations for cast-iron scrap are unchanged. Short, heavy, steel scrap as used in the foundries is at 55s. to 57s. 6d. delivered works. In the Lancashire area firm prices prevail. Cast-iron scrap of good machinery quality is offered between 50s. and 55s. per ton, according to the position of supplies and inclusive of delivery to Lancashire foundries. On the Scottish market demand generally is equal to the supply, with prices firm. First-quality, heavy, mild-steel melting scrap in furnace sizes is unchanged at 50s., while heavy basic or heavy iron and steel scrap mixed is at 45s. First-class machinery cast-iron scrap, in pieces not exceeding 1 cwt., is around 52s. to 53s., and heavy steelworks cast-iron scrap remains at 50s., with light cast-iron at 45s. per ton delivered f.o.t. consumers' works.

Metals

Copper.—This market has entered into a period of dulness both in this country and in the United States. According to the weekly market report issued by Messrs. Brandeis, Goldschmidt & Company, Limited, "the application of sanctions against Italy, coupled with the effect of the coming general election, have been reflected on the London market by a period of uncertainty. Very quiet conditions have made this market rather uninteresting, but the healthy undertone persists. Taking a long view, the outlook for copper appears still very good, and consumers should soon come into the market again. Of late, consumption has shown a steady improvement, and with reports from the various copper consuming trades favourable, it is likely that prices will be carried to a higher level in the not too distant future. It should again be emphasised that the diminishing possibility of war is not necessarily a sign that lower prices are to be expected, but should rather be considered as a bullish factor in as much as the domestic consumers appear to be awaiting a more peaceful outlook. European buying has been moderate, but from America reports point to quieter trading conditions, while producers seem to be well sold ahead."

Daily market prices:—

Cash.—Thursday, £34 18s. 9d. to £35 1s. 3d.; Friday, £35 3s. 9d. to £35 6s. 3d.; Monday, £34 18s. 9d. to £35; Tuesday, £35 3s. 9d. to £35 5s.; Wednesday, £35 8s. 9d. to £35 11s. 3d.

Three Months.—Thursday, £35 6s. 3d. to £35 7s. 6d.; Friday, £35 11s. 3d. to £35 12s. 6d.; Monday, £35 6s. 3d. to £35 7s. 6d.; Tuesday, £35 11s. 3d. to £35 12s. 6d.; Wednesday, £35 16s. 3d. to £35 17s. 6d.

Tin.—This metal has fluctuated considerably, and the market is very unsettled. Consumers are buying in a very cautious manner, as has been the case for some weeks. Undoubtedly some time must pass before the increased quotas take effect and stocks rise sufficiently to allow customers to be able to satisfy their requirements at reasonable quotations. According to the statistics published by Mr. W. H. Gartsen (Henry Rogers, Sons & Company) the total visible supply of tin at the end of October was 12,132 tons, as compared with 10,798 tons at the end of September.

Day-to-day fluctuations:—

Cash.—Thursday, £223 to £224; Friday, £223 5s. to £223 15s.; Monday, £223 to £224; Tuesday, £224 to £225; Wednesday, £225 to £225 10s.

Three Months.—Thursday, £212 10s. to £213; Friday, £214 to £214 10s.; Monday, £212 5s. to £212 10s.; Tuesday, £212 10s. to £212 15s.; Wednesday, £213 to £213 5s.

Spelter.—This market remains featureless, but the recently reported mild improvement in the galvanising industry has acted as an encouragement. High-grade zinc continues to be taken up in large quantities by the brass-making concerns. On the whole, consumption has been well maintained this week, but the amount of actual buying by consumers has declined. On the Continent, the state of the spelter market has been similar, but in the United States a quietly steady market is reported.

Official quotations were as follow:—

Ordinary.—Thursday, £16 7s. 6d.; Friday, £16 1s. 3d.; Monday, £16 1s. 3d.; Tuesday, £16 2s. 6d.; Wednesday, £16 6s. 3d.

Lead.—Consumption of this metal continues at a high level, and all available supplies are being readily absorbed. In recent months no foreign lead has been coming into this country, although output is, on the whole, well maintained. This indicates the extent of the recent improvement in the European demand for lead.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £17 7s. 6d.; Friday, £17 12s. 6d.; Monday, £17 10s.; Tuesday, £17 12s. 6d.; Wednesday, £18.

Notes from the Branches

Scottish Branch.—At the conclusion of the opening meeting of the Scottish Branch of the Institute of British Foundrymen the members and their friends met in the Ca'dora restaurant, Glasgow, for the annual social gathering. After tea, whist and music were enjoyed by members and ladies. Mr. R. D. Lawrie acted as master of ceremonies with conspicuous success. The whist prizes were presented to the winners by Mrs. Daniel Sharpe, wife of the Branch-President. Mr. Frank Hudson, Senior Vice-President, proposed an omnibus resolution, conveying the thanks of the meeting to the President for the jovial and efficient manner in which he had conducted the function, to Mrs. Sharpe for the gracious manner in which she had presented the prizes, to the secretary for the manner in which he had organised the arrangements, and to Mrs. Reid, Mr. Ballantine, Mr. Wallace and Mr. Bowsie for the musical items. The PRESIDENT, in returning thanks, on behalf of Mrs. Sharpe and himself, said it had been a pleasure to be present and to make contact with the members in a social capacity. It seemed to him that the function improved each year and he hoped it would continue to do so. He thought they should express their thanks to Mr. Lawrie for the able manner in which he had carried out his duties as M.C. and engineered the whist programme.

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RAW MATERIALS—PRICE LIST

(Wednesday, November 6, 1935)

COPPER

	£ s. d.
Standard cash	35 8 9
Three months	35 16 3
Electrolytic	40 0 0
Tough	38 5 0
Best selected	38 15 0
Sheets	68 0 0
India	50 0 0
Wire bars	40 0 0
Ingot bars	40 0 0
H.C. wire rods	43 15 0
Off. av. cash, Oct.	35 5 $2\frac{1}{16}$
Do., 3 mths., Oct.	35 12 $5\frac{1}{16}$
Do., Sttlmnt., Oct.	35 5 $2\frac{1}{16}$
Do., Electro, Oct.	39 19 $4\frac{5}{16}$
Do., B.S., Oct.	39 1 $4\frac{5}{16}$
Do., wire bars, Oct.	40 6 $6\frac{5}{16}$
Solid drawn tubes	10½d.
Brazed tubes	10½d.
Wire	6½d.

BRASS

Solid drawn tubes	9¾d.
Brazed tubes	11¾d.
Rods, drawn	8⅝d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7⅞d.
Wire	7¾d.
Rolled metal	7⅞d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£ s. d.
Standard cash	225 0 0
Three months	213 0 0
English	225 0 0
Bars	226 10 0
Straits (nom.)	228 10 0
Australian (nom.)	225 10 0
Eastern	220 5 0
Banca (nom.)	227 0 0
Off. av. cash, Oct.	227 8 $10\frac{16}{32}$
Do., 3 mths., Oct.	217 9 $1\frac{16}{32}$
Do., Sttlmt., Oct.	227 6 $11\frac{14}{32}$

SPELTER

	£ s. d.
Ordinary	16 6 3
Remelted	15 5 0
Hard	13 5 0
Electro 99.9	18 17 6
English	17 5 0
India	14 10 0
Zinc dust	19 10 0
Zinc ashes	4 10 0
Off. aver., Oct.	16 11 $1\frac{10}{32}$
Aver. spot, Oct.	16 8 $9\frac{15}{32}$

LEAD

	£ s. d.
Soft foreign ppt.	18 0 0
Empire (nom.)	18 7 6
English	20 0 0
Off. average, Oct.	18 4 $2\frac{5}{32}$
Average spot, Oct.	18 4 $2\frac{5}{32}$

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	24 12 6
Do., V.M. ex-whse.	25 10 0
Rods	29 0 0

ANTIMONY

	£ s. d.
English	83 0 0 to 84 0 0
Chinese, ex-whse.	71 0 0
Crude, c.i.f.	36 0 0

QUICKSILVER

	£ s. d.
Quicksilver	11 12 6 to 12 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£18 0 0 to £20 0 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	33 0 0
4/6% car.	21 15 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	34 0 0
Max. 1% car.	36 5 0
Max. 0.70% car.	37 5 0
70%, carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to 11 5 0
76/80% packed	£11 15 0 to 12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	2 17 6	to 3 0 0
Mixed iron and steel	2 13 0	to 2 15 0
Heavy cast iron	2 13 0	to 2 14 0
Good machinery	2 17 6	
Cleveland—		
Heavy steel	2 12 6	
Steel turnings	1 17 6	
Cast-iron borings	1 7 6	
Heavy cast iron	2 12 6	
Heavy machinery	2 14 0	to 2 16 6
Midlands—		
Light cast-iron scrap	2 7 6	
Heavy wrought iron	2 17 6	to 3 0 0
Steel turnings	1 15 6	
Scotland—		
Heavy steel	2 10 0	
Ordinary cast iron	2 13 0	
Engineers' turnings	2 0 0	
Cast-iron borings	1 17 6	to 1 18 9
Wrot-iron piling	2 17 6	to 3 0 0
Heavy machinery	2 2 6	

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	29 0 0
Brass	19 0 0
Lead (less usual draft)	15 5 0
Tea lead	11 10 0
Zinc	9 0 0
New aluminium cuttings	72 0 0
Braziery copper	26 0 0
Gunmetal	27 0 0
Hollow pewter	155 0 0
Shaped black pewter	120 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	71/-
Hematite M/Nos.	70/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	74/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	71/-
,, No. 3 fdry.	75/-
Northants forge	68/6
,, fdry. No. 3	72/6
,, fdry. No. 1	75/6
Derbyshire forge	71/-
,, fdry. No. 3	75/-
,, fdry. No. 1	78/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	73/6
Sheffield (d/d district)—	
Derby forge	68/6
,, fdry. No. 3	72/6
Lincs forge	68/6
,, fdry. No. 3	72/6
W.C. hematite	86/-
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	78/-
Staffs fdry. No. 3	78/-
Northants fdry. No. 3	77/6
Cleveland fdry. No. 3	78/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	81/6
Clyde, No. 3	81/6
Monkland, No. 3	81/6
Summerlee, No. 3	81/6
Eglinton, No. 3	81/6
Gartsherrie, No. 3	81/6
Shotts, No. 3	81/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

	£ s. d.	£ s. d.
Iron—		
Bars (cr.)	9 12 6	to 9 15 0
Nut and bolt iron	7 17 6	to 8 7 6
Hoops	10 10 0	and up.
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	and up.
Bolts and nuts, ¾ in. × 4 in.	15 0 0	and up.
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	9 5 0	to 9 7 6
Chequer plts.	10 7 6	
Angles	8 7 6	
Tees	9 7 6	
Joists	8 15 0	
Rounds and squares, 3 in. to 5½ in.	9 7 6	
Rounds under 3 in. to ¾ in. (Untested)	8 12 0	
Flats—8 in. wide and over	8 12 6	
,, under 8 in. and over 5 in.	8 17 6	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 5 0	to 12 10 0
Hoops (Staffs)	9 7 0	
Black sheets, 24g. (4-t. lots)	11 5 0	
Galv. cor. shts. (,,)	13 5 0	
Galv. flat shts. (,,)	13 15 0	
Galv. fencing wire, 8g. plain	14 10 0	
Billets, soft	5 10 0	and up.
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 10 0	to 5 12 6
Tin bars	5 10 0	to 5 12 6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.31
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	20/- to 21/-
,, furnace	16/6 to 17/9
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/9
,,	28×20 ,,	37/6
,,	20×10 ,,	27/-
,,	18¾×14 ,,	19/6
C.W.	20×14 ,,	15/6 to 15/9
,,	28×20 ,,	33/6 to 34/-
,,	20×10 ,,	22/9
,,	18¾×14 ,,	15/9

SWEDISH CHARCOAL IRON & STEEL

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars-hammered, basis	£16 0 0	to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0	to £16 0 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£30 0 0	to £31 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, st'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£ s. d.	
Oct. 31 ..	34 18 9 inc.	2/6
Nov. 1 ..	35 3 9 „	5/-
„ 4 ..	34 18 9 dec.	5/-
„ 5 ..	35 3 9 inc.	5/-
„ 6 ..	35 8 9 „	5/-

Electrolytic Copper

	£ s. d.	
Oct. 31 ..	39 5 0 No	change
Nov. 1 ..	39 15 0 inc.	10/-
„ 4 ..	39 15 0 No	change
„ 5 ..	39 15 0 „	„
„ 6 ..	40 0 0 inc.	5/-

Standard Tin (cash)

	£ s. d.	
Oct. 31 ..	223 0 0 inc.	105/-
Nov. 1 ..	223 5 0 „	5/-
„ 4 ..	223 0 0 dec.	5/-
„ 5 ..	224 0 0 inc.	20/-
„ 6 ..	225 0 0 „	20/-

Tin (English ingots)

	£ s. d.	
Oct. 31 ..	223 0 0 inc.	100/-
Nov. 1 ..	223 10 0 „	10/-
„ 4 ..	223 0 0 dec.	10/-
„ 5 ..	224 10 0 inc.	30/-
„ 6 ..	225 10 0 „	20/-

Spelter (ordinary)

	£ s. d.	
Oct. 31 ..	16 7 6 inc.	2/6
Nov. 1 ..	16 1 3 dec.	6/3
„ 4 ..	16 1 3 No	change
„ 5 ..	16 2 6 inc.	1/3
„ 6 ..	16 6 3 „	3/9

Spelter (Electro, 99.9 per cent.)

	£ s. d.	
Oct. 31 ..	18 17 6 dec.	1/3
Nov. 1 ..	18 15 0 „	2/6
„ 4 ..	18 15 0 No	change
„ 5 ..	18 15 0 „	„
„ 6 ..	18 17 6 inc.	2/6

Zinc Sheets (English)

	£ s. d.	
Oct. 31 ..	24 12 6 No	change
Nov. 1 ..	24 12 6 „	„
„ 4 ..	24 12 6 „	„
„ 5 ..	24 12 6 „	„
„ 6 ..	24 12 6 „	„

Lead (English)

	£ s. d.	
Oct. 31 ..	19 10 0 No	change
Nov. 1 ..	19 10 0 „	„
„ 4 ..	19 10 0 „	„
„ 5 ..	19 10 0 „	„
„ 6 ..	20 0 0 inc.	10/-

AVERAGE MONTHLY PRICES OF RUBIO ORE (MIDDLESBROUGH).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	0 15 3	0 15 6	0 15 3	0 15 0	0 14 0	0 14 3	0 14 3	0 14 0	0 14 0	0 15 0	0 14 3	0 15 3	0 14 8
1898	0 15 0	0 14 4	0 14 9	0 14 6	0 15 0	0 15 0	0 14 0	0 14 0	0 14 0	0 14 9	0 15 0	0 14 9	0 14 7
1899	0 15 0	0 15 3	0 15 6	0 15 6	0 15 9	0 16 0	0 17 6	0 18 0	0 17 9	0 18 0	0 19 0	1 0 0	0 16 11½
1900	1 1 0	1 0 6	1 1 0	1 0 9	1 1 0	1 1 0	1 1 3	1 1 6	1 1 3	1 1 3	1 0 0	0 18 0	1 0 8½
1901	0 17 6	0 16 0	0 15 0	0 14 6	0 15 6	0 15 9	0 14 9	0 15 3	0 15 9	0 15 9	0 15 9	0 15 9	0 15 7½
1902	0 15 6	0 15 0	0 16 0	0 16 0	0 15 6	0 15 3	0 15 6	0 16 0	0 16 0	0 16 0	0 15 9	0 15 6	0 15 8½
1903	0 15 6	0 16 0	0 16 6	0 16 3	0 16 3	0 16 10	0 15 9	0 15 6	0 15 6	0 14 9	0 14 9	0 15 1	0 15 6
1904	0 14 9	0 15 3	0 15 1	0 15 4	0 15 3	0 15 0	0 14 5	0 14 6	0 14 6	0 14 6	0 14 6	0 14 7	0 14 9½
1905	0 15 3	0 15 6	0 15 0	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 16 6	0 18 6	0 18 9	0 18 9	0 16 3½
1906	1 0 0	1 1 6	1 0 0	1 0 0	0 19 6	1 0 0	0 19 6	0 19 4	1 0 6	1 1 6	1 1 9	1 3 6	1 0 7
1907	1 3 6	1 2 6	1 2 6	1 2 0	1 1 6	1 2 3	1 2 3	1 ° 0	1 1 0	0 19 0	0 18 9	0 17 6	1 1 2½
1908	0 16 6	0 15 0	0 15 6	0 15 6	0 15 3	0 15 0	0 15 0	0 14 9	0 15 0	0 16 0	0 16 0	0 16 0	0 15 5½
1909	0 15 9	0 16 3	0 16 0	0 16 0	0 16 3	0 16 6	0 16 0	0 16 0	0 17 0	0 17 0	0 17 6	0 17 6	0 16 6
1910	1 0 4	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 3	1 0 3	1 0 6½	1 1 3	1 1 3	1 0 9½
1911	1 2 2½	1 2 6	1 2 6	1 1 11½	0 19 6	0 19 6	0 19 0	0 19 0	0 19 1½	0 19 6	1 0 0½	1 1 6½	1 0 7½
1912	1 2 3	1 2 6	1 2 6	1 1 1½	1 1 6	1 1 6	1 1 6	1 2 3	1 2 6	1 3 0	1 3 0	1 2 11	1 2 2½
1913	1 2 9	1 2 2	1 1 7½	1 1 6	1 0 8½	1 0 0	1 0 0	1 0 0	0 19 10½	0 19 1½	0 19 0	0 19 0	1 0 3½
1914	0 18 7½	0 18 0	0 18 0	0 17 9	0 17 6	0 17 6	0 17 1½	0 19 7½	0 18 11½	0 17 10½	0 18 7½	1 1 0½	0 18 5½
1915	1 7 7½	1 8 6	1 9 3	1 10 2½	1 8 6	1 6 4	1 5 10½	1 6 0	1 6 10½	1 10 8½	1 13 0	1 17 10	1 9 1½
1916	1 18 6	2 0 1½	2 2 6½	2 0 6½	1 15 0	1 16 3	1 18 0	1 18 0	1 18 0	—	—	—	—
1917	} Price Fixed												
1918													
1919	—	—	—	—	2 5 7½	2 14 4½	2 16 4½	2 14 0	2 13 4½	2 13 0	2 12 7½	2 11 9	—
1920	2 17 0	3 7 9	2 15 6	3 6 7	3 0 0	2 15 0	2 14 0	2 9 9	2 7 6	2 11 0	2 12 3	2 10 0	2 15 0
1921	2 1 0	2 0 1½	1 18 3	1 17 6	1 17 6	1 17 6	1 17 6	1 5 0	1 8 9½	1 7 9	1 7 0	1 7 0	1 13 8½
1922	1 6 7½	1 5 10½	1 6 11	1 7 0	1 7 0	1 7 0	1 5 3	1 4 9½	1 4 2½	1 3 3½	1 2 6	1 2 3	1 5 2½
1923	1 2 9½	1 4 6½	1 5 2	1 4 8½	1 4 6	1 3 6	1 3 6	1 3 0	1 3 0	1 3 0	1 3 2½	1 4 9	1 3 10½
1924	1 4 2½	1 4 0	1 4 0	1 3 7½	1 3 8½	1 3 6	1 2 11	1 2 6	1 2 1½	1 1 7½	1 2 3	1 2 6	1 3 1
1925	1 2 6	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 6	1 0 6	1 0 0	1 0 0	1 0 0	1 0 3	1 0 10½	1 1 1½
1926	1 1 1½	1 1 6	1 1 6	1 1 3½	1 1 3	1 1 5½	1 1 6	1 1 6	1 1 0	1 1 6	1 1 6	—	1 1 4½
1927	1 2 1½	1 2 3	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 7½	1 1 6	1 1 0	1 1 0	1 1 0	1 1 0	1 1 7½
1928	1 1 0	1 1 1½	1 1 11	1 2 4½	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 2½
1929	1 2 6	1 2 6½	1 2 11½	1 3 0	1 3 0	1 3 2½	1 4 0	1 4 8½	1 4 7½	1 4 6	1 4 6	1 4 3	1 3 7½
1930	1 3 3½	1 2 6	1 1 9	1 1 6	1 0 10½	1 0 0	1 0 0	0 19 6	0 19 6	0 17 4½	0 16 4½	0 16 4½	0 19 10½
1931	0 16 1½	0 16 0	0 16 0	0 15 11½	0 15 4½	0 15 0½	0 14 10½	0 14 3½	0 14 6	0 16 8½	0 17 0½	0 16 6	0 15 9
1932	0 16 6	0 16 6	0 16 3	0 15 6	0 15 4½	0 15 0	0 14 11	0 14 8½	0 14 6	0 14 6	0 14 9	0 15 1	0 15 3½
1933	0 15 6	0 15 3	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 11½	0 16 6	0 16 6	0 15 7½
1934	0 16 6	0 17 6	0 16 9	0 16 6½	0 16 8½	0 16 9½	0 17 0	0 17 0	0 17 0	0 17 0	0 17 0	0 17 0	0 16 10½
1935	0 17 0	0 17 4½	0 17 6	0 17 6	0 17 6	0 17 6	0 17 6	0 17 6	0 17 6	0 17 7½	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

MALLEABLE Foundry Commercial Manager desires appointment with progressive company.—Apply Box 448, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

YOUNG MAN, single, age 29, desires position as foreman or assistant anywhere abroad. Experienced. Guaranteed to get results. Iron; semi-steel; jobbing. Repetition. —Box 454, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT Foreman Steel Moulder required for large European foundry in India. A man not over 35 who has held similar position or that of leading moulder and has had wide experience with jobbing steel castings up to 5 tons weight in green, dry and loam preferred. Similar experience with iron an advantage. Five-year agreement with provident fund, free medical attention and free passages out and home. Salary according to qualifications. Generous leave with free passages if re-engaged. Apply by letter stating age, and whether married or single, and enclosing copies of testimonials to "STRICKLE," c/o W. ABBOTT, LTD., 32, Eastcheap, London, E.C.3.

WANTED.—Traveller on commission with good connection in London district to represent iron foundry producing high-class engineering castings.—Box 458, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENCY

CHILLED and Grain Rolls, Rolling-Mill Plant, etc.—Specialist, well known throughout iron, steel and non-ferrous trades, with exceptional and important managerial experience in manufacturing and selling organisation, desires representation and consulting appointments with sound progressive firms Communications treated confidentially.—Box 456, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

FOR SALE.—10-ton Universal Testing Machine in excellent condition.—T. C. HOWDEN & Co., 7, Fleet Street, Birmingham.

THREE "Rapid" pneumatic Squeezers: plain-squeeze type; no pattern draw. Price £9 each.—ALEX. HAMMOND, Foundry Machinery Merchant, Slough.

FOR SALE.—One Jackman Junior Cupola in excellent condition; size No. "0"; capacity 10-15 cwts. per hr.; complete with motor-driven fan. 400 volts, 3 phase, 50 periods. For prices and particulars apply Box 452, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

THOS. W. WARD LTD.

Pridmore Pneumatic Rollover MOULDING MACHINE; two air cyls., 10½" dia. x 12" stroke; take boxes 3' 6" x 2'.

Inclining TUMBLING BARREL (Canning); 22" dia. x 18" deep barrel; 50 r.p.m.

Nearly new high-class STEAM TRACTOR VERT. BOILER; about 5' 6" high x 2' 10½" dia.; 250 lbs. w.p.

Two steel vertical BOILING PANS; 10' high x 7' 4" dia.; 55 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued*

TWO roller-bearing, double-ended Fettling-shop Grinders, complete with new wheels 24 in. by 3 in. on each machine. Thoroughly modern machines in perfect condition; as new. Offered cheap.—ALEX. HAMMOND, Foundry Machinery Merchant, Slough.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

MISCELLANEOUS

STEEL Chimney Stack for sale; self-supporting, 150 ft. high, 12 ft. dia. at base, tapering to 6 ft. Wrought-iron ladder. First-class condition.—HOLINTER, LTD., Leeds Steel Works, Leeds.

WEIGHING MACHINES.

3-TON Avery Weighing Machine, with 24-in. gauge rails.

1-ton Avery Weighing Machine, ordinary platform type with modern steel yard; as new.

½-ton Avery Weighing Machine, portable type with loose weights.

5-cwt. Avery Weighing Machine, portable type with loose weights.

2-ton Avery Crane Weigher, dial type.

10-ton Denison Crane Weigher.

15-ton Denison Crane Weigher.

20-ton Denison Crane Weigher.

30-ton Denison Crane Weigher.

All above in stock, offered cheap. Re-stamped ready for use.

ALEX. HAMMOND,
Foundry Machinery Merchant,
SLOUGH.

'Phone: 287 SLOUGH

SAND PLANT

Herbert Whizzer, large size. **£48.**
Brealey Disintegrator, NEW. **£26.**
Pneumatic Riddles, Jackman type. **£9 each.**

SANDBLAST PLANT

BARREL PLANT by Tilghman, *as new*, 60"×40". Price **£240.**

NEW 8'×8' ROOM PLANT, complete. Price **£230.**

CAST IRON ROOM PLANT, 12'×9', complete with 400 cu. ft. motor-driven compressor for A.C. current, in new condition. Cheap.

Several small complete barrel plants in stock.

Genuine Stevenson 30-ton Crane Ladle, NEW. Price **£75.**

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

MISCELLANEOUS—*Continued*

MALLEABLE Foundry required, interested in manufacture of small and medium castings.—Apply Box 450, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SELECT YOUR MACHINE FROM THE LARGEST STOCK OF HIGH-CLASS SECONDHAND MOULDING MACHINES IN THE WORLD

Practical Advice Free

THE COLEMAN FOUNDRY EQUIPMENT Co LTD
156, STRAND, LONDON, W.C.2.

WHEN THINKING OF SANDBLAST THINK OF RICHARDSON'S
Established 1887.

We Supply Re-Conditioned & New SAND BLAST PLANTS AND AIR COMPRESSORS.

Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.

Phone: MIDLAND 2281.
Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.

IDAHO PINE YELLOW PINE

PRIME & PATTERN GRADES
½" to 3" thick
Width up to 24" wide
All free of centre heart and shake

CHETHAM TIMBER Co., Ltd.,
70, FINSBURY PAVEMENT, LONDON, E.C.2
Metropolitan 7418